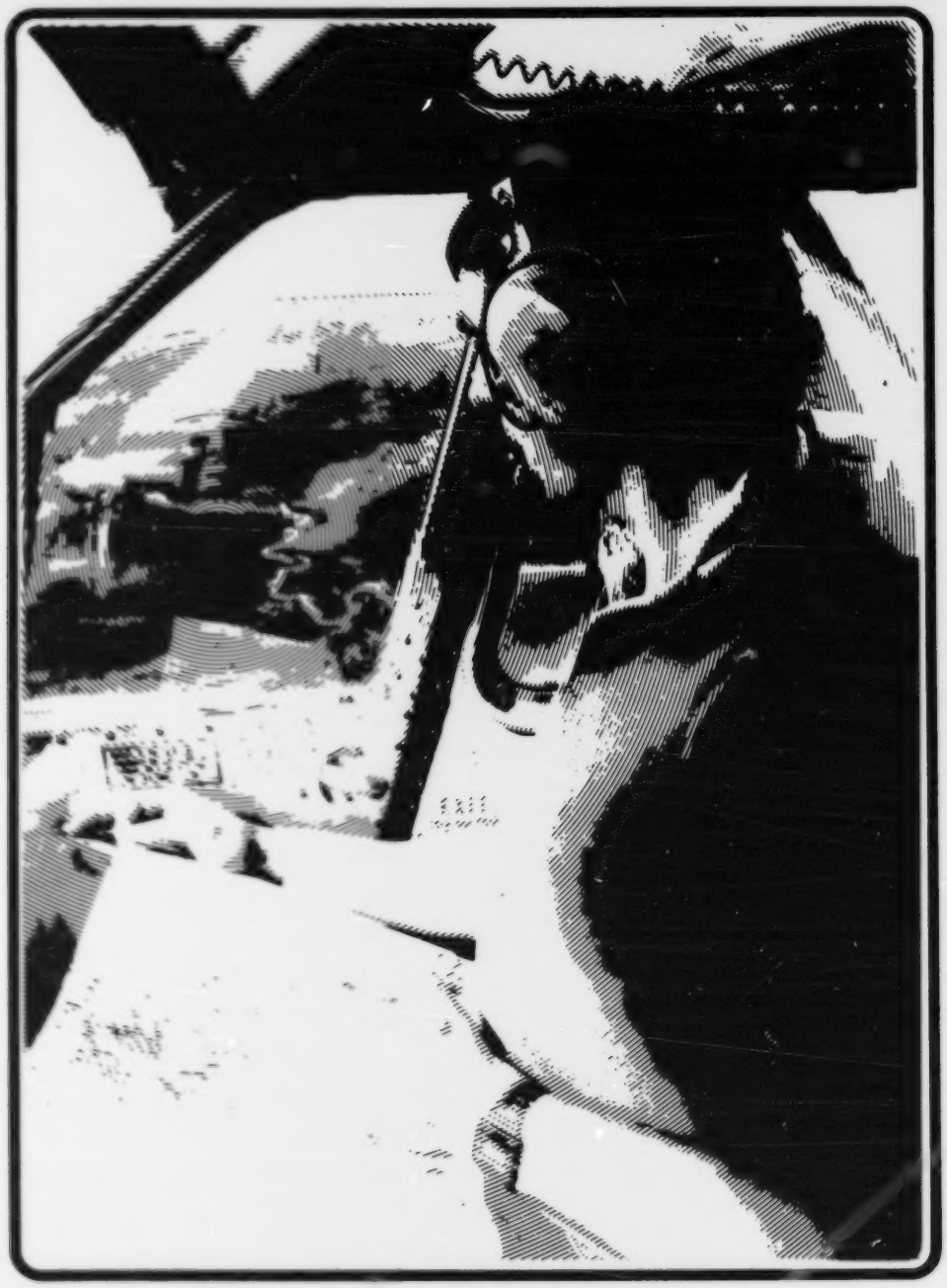
# Forest Insect and Disease Conditions in Canada 1986



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Cover: FIDS-GLFC technician Alan Keizer aerial sketch-mapping insect infestation.

# Forest Insect and Disease Conditions in Canada 1986

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## Dr. B.H. Moody

Ben joined the Canadian Forestry Service in 1977 as a forest entomologist at the Newfoundland Forestry Centre in St. John's Newfoundland, where he was involved with the spruce budworm population dynamics studies and provided functional guidance and direction to the Forest Insect and Disease Survey (FIDS). In 1980, Ben transferred to the Northern Forestry Centre, Edmonton, Alberta and shortly after became FIDS Head. In 1987, Ben replaced Bob Taylor who has left the CFS, as Scientific Advisor to the FIDS program.

# Introduction

In 1986 the Forest Insect and Disease Survey celebrated 50 years of service to the needs of forestry in Canada. The forest insect survey was formally established in 1936 to fulfill a growing need for information and extension services. Its origin was closely related to the severe European spruce sawfly outbreak in Eastern Canada and its primary objective was to follow the population level and spread of this one insect. From this small beginning the survey rapidly expanded to include forest insects generally. In 1951 the Forest Biology Division (Science Service) was organized to coordinate all activities of the Science Service relating to forestry. The division consisted of two principal units: forest zoology and forest pathology. In 1951 the name Forest Insect and Disease Survey was adopted.

Today the Forest Insect and Disease Survey is a nationally coordinated program of six regional FIDS units and the FIDS Technology Development Project. Activities are managed by the regional CFS establishments. The program provides perspectives on insects and disease, including acid rain, to forest managers, quarantine agencies, researchers, educators, and the public. Significant changes are now being made by FIDS through its new Strategic Plan, which has been largely accepted by CFS senior management. The FIDS Strategic Plan defines the FIDS role and responsibilities in relation to other federal and provincial agencies, and provides guidance for the FIDS program development and activities over the next several years. The levels of provincial and industry involvement and their roles in Forest Insect and Disease Surveys are becoming increasingly diverse across Canada. Therefore the advantages of delegating routine Field Survey Activities to the provinces are countered by the need to maintain the capacity to carry out federal mandates.

The proposed strategic direction for FIDS includes:

1) Intelligence gathering: analysis and generation of knowledge, and forecasting or prediction;
2) Identification of federal/provincial survey responsibility;
3) Identification and establishment of the FIDS role in the Plant Quarantine Act and in interprovincial, and international marketing relationships.

*Forest Insect and Disease Conditions in Canada 1986* is the sixth in the series of national annual reports of the Forest Insect and Disease Survey. This series replaces the *Annual Report of the Forest Insect and Disease Survey*. Since its first issue in 1981, the volume of information has doubled.

In cooperation with those responsible for improving forest inventory and economic data in Canada, the survey is attempting to provide more quantitative and interpretive data on damage and depletion caused by forest pests. The new initiative requires the development of methodologies and procedures before complete and accurate data can be made available. As forest management intensifies and the old growth forests are gradually replaced by new, managed forests, new pest problems and impacts will arise and require increased attention (for example, the spruce budworm). Accordingly, our regional and national reporting will continue to be modified to reflect the changing activities and findings of the survey.

This report is produced through a cooperative effort of the six regional establishments of the Canadian Forestry Service. In the 1985 report we introduced our FIDS Technology Development Project to coordinate technology development for FIDS. Based at the Petawawa National Forestry Institute (PNFI), the project draws on the strength of resident expertise in computing, data analysis, remote sensing, and modeling for use in support of FIDS activities. The project's objectives are:

1) To plan, develop, and implement forest pest management information systems;
2) To develop and apply new technology in data handling, analysis, remote sensing, and modeling, in cooperation with the CFS regions and the PNFI projects in these disciplines.

A system, known as FIDS INFOBASE, based on advanced methods of data storage and retrieval has been developed to bring pest information to FIDS on demand. The system can accept and provide field data from the Acid Rain National Early Warning System (ARNEWS) network of plots. This database is used to search for trends in vegetation which may be associated with acid rain or other causes. Application of "geographic information systems" (GIS) is also being phased into the project for FIDS research.

In this report, pests considered to be currently most significant in terms of their present or potential economic, sociological, or environmental impact are described in detail under "Major Forest Insects and Diseases." Regional surveys of pest problems in special situations or of specific pests are summarized under "Special Surveys." The status of many other pests is presented in tabular form by region under the title "Other Insects, Diseases, and Damage." This section has been expanded since 1983 to reflect the importance of these pests. Although they do not, in most cases, have spectacular effects, they are important because of their potential for expansion, quarantive considerations, and as vectors and indicators of other problems. Also, they sometimes create losses

due to their insidious nature. Additional information on these and other pests can be obtained from the regional forestry centers of the Canadian Forestry Service.

There are several insidious forest pests in Canada that are not amenable to routine detection surveys and therefore not to annual census; nevertheless, they do cause significant losses. This report recognizes the importance of these pests through periodic descriptive if not quantitative reviews of them.

When possible in this report we use current nomenclature and authorship to designate pest species. Because the taxonomy of some species changes occasionally and old names tend to persist after a change, we strive to realistically balance clear communication to our audience and incorporation of taxonomic revision.

In recent years we have personalized the cover of this report by showing some of our personnel in action. This year one of our Great Lakes Forestry Centre technicians, Alan Keizer, is shown aerial sketch-mapping insect infestations.

In addition to those already named we would like to acknowledge the field and laboratory staffs of the forestry centres; officers of provincial and federal governments and agencies; the forest industry; private individuals; and especially the assistance provided by Mrs. J. Tomlinson, chief of the Scientific and Technical Publications Division. We would mention that the Quebec Department of Energy and Resources, Service de la protection contre les Insectes et les Maladies, provided most of the Information from Quebec, except the pinewood nematode survey and balsam fir special survey, through the FIDS unit at the Laurentian Forestry Centre. Finally, we thank those who provided us with comments and suggestions on previous reports.

**E.S. Kondo**
*Director, Forest Insect and Disease Survey*

**B.H. Moody**
*Scientific Advisor*

# Summary of Defoliation and Damage Estimates

A summary of the areas affected in 1986 by the major defoliating insects or bark beetles is presented here for the first time in one table to illustrate the magnitude of these problems. This is done in full realization that strict comparison is not possible: usually a succession of defoliation-years is required to kill a tree, and this varies with the pest, the tree species being attacked and other factors, some of which may be poorly understood; also growth losses incurred as a result of pests and the factors which influence these losses that are even less well known; and differences in survey methodologies for each pest which further complicate comparisons.

This table is not a ranking of importance then, but a general guide and 1986 estimates of the impacts of these major pests on our forests.

Table 1. Selected major pests: Summary of estimates of areas of moderate to severe defoliation or areas of beetle-killed trees in 1986 ('000 ha).

| Province or Territory | Spruce budworms | Jack pine budworm | Mountain pine beetle[a] | Hemlock looper | Forest tent caterpillar | Gypsy moth |
|---|---|---|---|---|---|---|
| Newfoundland | 2 | — | — | 215 | — | — |
| Prince Edward Island | 65 | — | — | — | — | — |
| Nova Scotia | 289 | — | — | — | 1 | — |
| New Brunswick | 927 | — | — | — | — | — |
| Quebec | 2 100 | — | — | — | 479 | — |
| Ontario | 8 856 | 1 744 | — | — | 433 | 168 |
| Manitoba | 34 | 132 | — | — | 1 | — |
| Saskatchewan | 18 | 176 | — | — | 398 | — |
| Alberta | 1 | — | 1 | — | 602 | — |
| British Columbia[b] | 695 | — | 94 | — | 94 | — |
| Total (Canada) | 12 385 | 2 052 | 94 | 215 | 2 007 | 168 |

[a] Areas where beetle-killed trees occurred.
[b] Western spruce budworm caused light to moderate defoliation on an additional 413 000 ha.

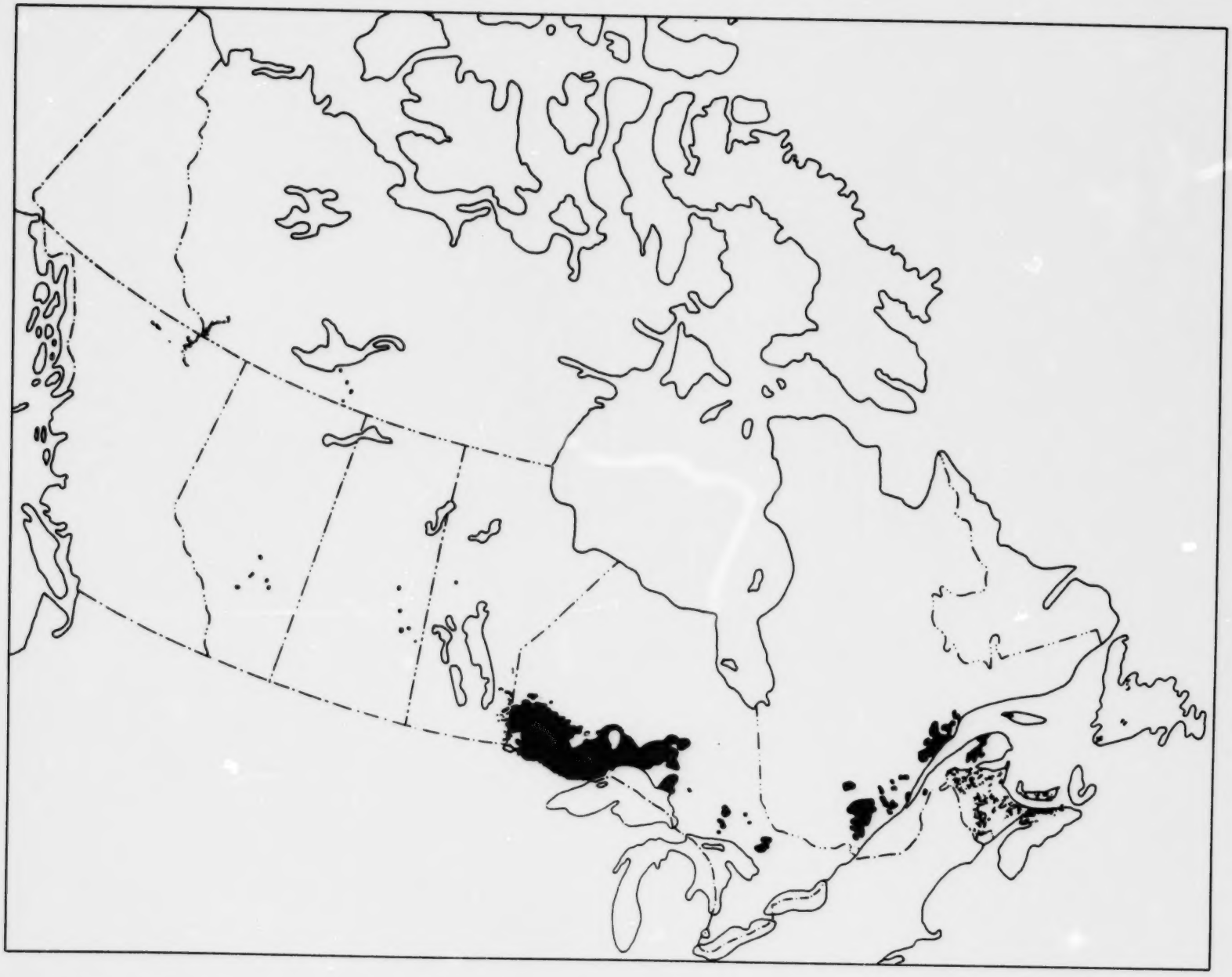

**Figure 1.** Areas of moderate-to-severe defoliation by the spruce budworm.

# Major Forest Insects and Diseases

## Spruce budworm

*Choristoneura fumiferana* (Clem.)

The spruce budworm remains as Canada's most destructive forest pest. Balsam fir is the preferred host of the spruce budworm although it feeds heavily on red spruce, white spruce, and to a lesser extent on black spruce. At very high population levels, this budworm will also attack hemlock and larch. In 1986, the total area of moderate to severe defoliation by the spruce budworm decreased to 12.3 million ha (Figure 1). The infestations decreased in Nova Scotia, New Brunswick, Quebec, Ontario, and the Prairie Provinces with only slight increases in small areas in Newfoundland, Prince Edward Island, and British Columbia. In some areas, other insects and diseases, such as the spruce beetle and Armillaria root rot, continue to increase in stands weakened by repeated budworm defoliation and, in turn, have themselves attacked and killed trees. These are discussed later in this report.

A complete survey of dead and dying trees was not conducted in 1986; however, some regions have reported updated figures and tree mortality in permanent impact plots. In particular, Ontario continued to report an increase in the area exhibiting tree mortality.

Aerial spray operations were conducted in all provinces from Manitoba eastward except for Prince Edward Island and Newfoundland, covering a total of 0.8 million ha (Figure 2). Table 2 shows the areas of moderate to severe defoliation by province and areas sprayed to control the spruce budworm in 1986.

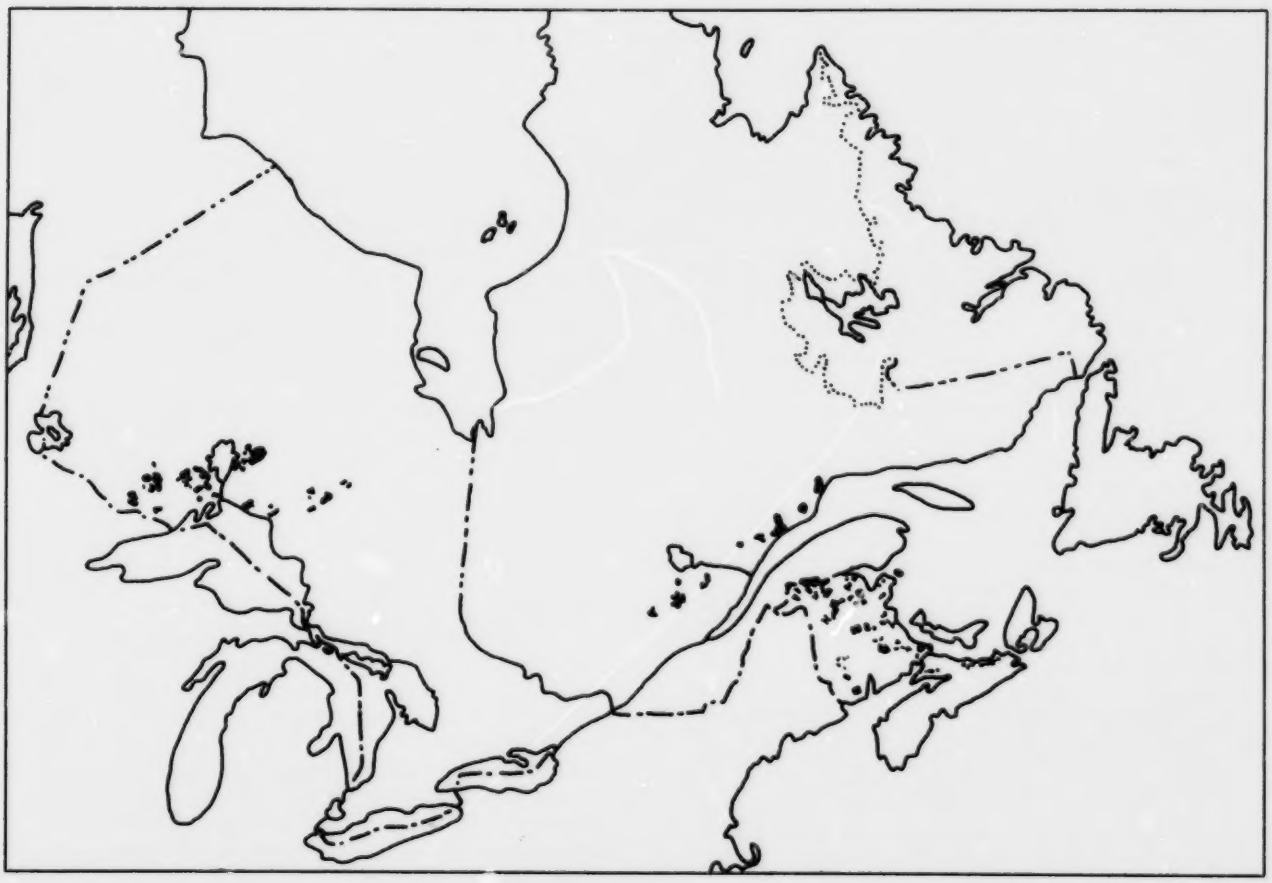

**Figure 2.** Locations of aerial spray operations against the spruce budworm in eastern Canada.

Table 2. Areas of moderate to severe defoliation by province and aerial spraying to control the spruce budworm in 1986.

| Province | Area of moderate to severe defoliation ('000 ha) | Area sprayed ('000 ha) |
|---|---|---|
| Newfoundland | 2 | 0 |
| Prince Edward Island | 65 | 0 |
| Nova Scotia | 289 | 58 |
| New Brunswick | 927 | 575 |
| Quebec | 2 100 | 51 |
| Ontario | 8 856 | 147 |
| Prairie provinces | 52 | <1 |
| Northwest Territories | 18 | 0 |
| TOTAL | 12 309 | 831 |

## Newfoundland

***Defoliation*** — The decreasing major outbreak of the spruce budworm collapsed in 1985 and limited egg surveys and overwintering larval surveys indicated that no moderate and severe defoliation would occur in 1986. Light defoliation was forecast for 1986 on about 7 500 ha distributed mostly in western Newfoundland. However, larval sampling showed high budworm numbers at three locations near South Branch, Baie Verte, and Noel Paul's Brook. Severe defoliation occurred on about 2 200 ha and light defoliation was recorded on 1 800 ha. Generally, field sampling in 1986 showed an increase in budworm numbers throughout western Newfoundland, even in areas without any noticeable defoliation.

***Control*** — There was no operational or experimental control program conducted against the spruce budworm in 1986. Samples of spruce budworm were collected from a residual population near Baie Verte. The major larval parasite was *Glypta fumiferanae*, but the usually abundant *Apanteles fumiferanae* was very scarce this year. The major pupal parasite was *Phaeogenes hariolus*. About 15% of spruce budworm samples were parasitized. Less than 1% of the spruce budworm samples were infected by the entomopathogenic fungi, *Paecilomyces farinosus* and *Erynia radicans*. No microsporidian disease was detected in the samples.

***Forecast*** — Egg and overwintering larval samples were collected in conjunction with the hemlock looper egg survey in mid-October. The area of light, moderate, and severe defoliation forecast for 1987 is about 34 000 ha including 9 800 ha in the moderate and severe category. Moderate and severe defoliation is expected in two locations, near South Branch and Baie Verte. Light defoliation is forecast to occur in several areas throughout southwestern Newfoundland and near Noel Paul's Brook.

## Nova Scotia

***Defoliation*** — Defoliation of balsam fir and spruce in softwood and mixedwood stands occurred on 431 300 ha in Nova Scotia in 1986. (Figure 1). Defoliation was severe on 5 900 ha, moderate on 282 700 ha, and light on 142 700 ha. The moderate defoliation class includes 76 000 ha where severely defoliated patches were interspersed throughout moderately defoliated areas.

Although the total area of defoliation increased in 1986 from the 345 200 ha recorded in 1985, the area of moderate and severe defoliation categories decreased to 288 600 ha from 318 000 ha reported in 1985. This decrease alone is noteworthy but more important is that in 1985 all but 32 000 ha of this area was severely defoliated, but in 1986 only 5 900 ha falls into this category. All of the noticeable defoliation recorded in the province occurred in the northern mainland counties of Cumberland, Colchester, Pictou, and Antigonish.

***Damage*** — There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in Nova Scotia in 1986.

The condition of balsam fir subjected to an uncontrolled spruce budworm outbreak has been followed on permanent research plots on both the Highland and Lowland areas of Cape Breton Island since 1976. By the end of 1985, tree mortality, attributed to spruce budworm attack, was 82% on the Highlands and 91% on the Lowlands. Only 10% of the merchantable balsam fir on the Highlands and 6% on the Lowlands survived the outbreak. Although spruce budworm populations decreased drastically in 1981 from those at the height of the outbreak, losses continued to mount with many of the weakened trees falling victim to a complex of secondary organisms, and in recent years to blowdown. The apparent slowdown in losses is a classical case of "not much left to die" at these levels of stand destruction.

***Control*** — In 1986 control operations in Nova Scotia were conducted by the Nova Scotia Department of Lands and Forests on 56 155 ha and by J.D. Irving Ltd. on 2 022 ha, for a total of 58 177 ha. The biological control agent B.t. (Dipel® 132R), at the rate of 30 BIU/ha, was the only control agent used. All but 35 ha was treated aerially.

***Forecast*** — Overwintering larval surveys ($L_2$) completely replaced the traditional egg mass surveys for the first time in Nova Scotia in 1985, and results from these constitute the sole base from which predictions are made. The $L_2$ survey was conducted by the Nova Scotia Department of Lands and Forests, with sampling assistance from Bowater-Mersey Ltd. personnel.

Information from 420 sample locations shows that the total area of infestation has not changed much between 1985 and 1986, but there is a 90% reduction

in the areas of extreme infestation, and a 38% reduction in high infestations. However, there is a 26% increase in the areas of moderate infestation. Populations are negative or low in 12 counties. Moderate population levels are present at 21% of the sample locations in Annapolis County and only one location was "moderate" in Shelburne County. Most of the infestations were found in Cumberland-Colchester-Pictou-Antigonish counties on the northern mainland where 5% of the samples indicate extreme, 11% high, and 25% moderate infestations. Spruce and fir trees in areas supporting moderate to extreme spruce budworm populations are at risk of noticeable defoliation in 1987.

## Prince Edward Island

***Defoliation*** — Defoliation of balsam fir and spruce stands occurred throughout Prince Edward Island and affected 98 000 ha in 1986. Defoliation was severe on 600 ha, moderate on 64 000 ha, and light on 33 400 ha (Figure 1). The moderate defoliation class includes 23 000 ha where severely defoliated patches were interspersed throughout the moderately defoliated area.

***Damage*** — There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in 1986.

***Control*** — No control measures on an operational scale were carried out against the spruce budworm in 1986.

***Forecast*** — Since 1984 the overwintering larval survey ($L_2$) has been used in Prince Edward Island to predict populations for the following year. In 1986 the $L_2$ survey included 42 locations throughout the province. Of these 5% are in the high, 37% in the moderate, and 58% in the low or negative infestation category. Compared to results obtained in 1985, when populations were extreme at 9%, high at 33%, moderate at 29%, and low or negative at 29% of the locations sampled, spruce budworm populations are expected to decrease in 1987. The highest counts were obtained in Queens and in southern Kings counties where the most serious defoliation can be expected. In addition, pockets of moderate defoliation are likely to occur elsewhere.

## New Brunswick

***Defoliation*** — Defoliation of balsam fir and spruce stands was recorded on over 1.087 million ha in the province in 1986 (Figure 1). Defoliation was severe on 698 000 ha, moderate on 229 000 ha and recorded as light on 160 000 ha. The total area of defoliation is almost the same as was recorded as moderate and severe in 1985 (1.070 million ha). The 927 000 ha of moderate and severe defoliation in 1986 represents a 13% decrease from 1985 (1.070 million ha), a 27% increase from 1984 (730 000 ha), and a considerable (54%) decrease from the 2.028 million ha recorded in these categories in 1983.

***Damage*** — There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in New Brunswick in 1986.

***Control*** — Foliage protection against the spruce budworm in New Brunswick was conducted over 545 500 ha in 1986; 496 000 ha by Forest Protection Ltd. and 49 500 ha by Forest Patrol Ltd., a subsidiary company of J.D. Irving Ltd.

Forest Protection Ltd. treated 126 000 ha with two applications of aminocarb (Matacil® 180F), 118 000 ha with two applications of fenitrothion (Sumithion®), and 141 000 ha received a single application of one chemical, followed by the other. The biological control agent B.t. (Dipel® 132) was applied over 111 000 ha. The rate of application was 210g/ha for fenitrothion, 70g/ha for aminocarb and 30 BIU/ha for B.t. Most of the chemical treatments were applied in water-based formulations while B.t. was applied undiluted.

Forest Patrol Ltd. treated all but 30 ha of the 49 500 ha in their program with aminocarb (Matacil® 180F) or fenitrothion (Sumithion®). The 30 ha received a single application of B.t. (Dipel® 132) at the rate of 30 BIU/ha. Over 96% of the chemically treated area received a double application, at the rate of 210g/ha for fenitrothion and 90g/ha for aminocarb.

***Forecast*** — The traditional egg mass surveys for predicting spruce budworm infestation levels were replaced by the overwintering larval survey ($L_2$) in New Brunswick in 1985. In 1986, the New Brunswick Department of Natural Resources and Energy processed samples from 1586 areas, of which 3% are in the high, 20% in the moderate, and 77% in the low infestation categories. The high and moderate populations of the spruce budworm occur throughout much of the northern part of the province and in smaller, though considerable, areas elsewhere. The total area forecast to support populations capable of causing damaging levels of defoliation in 1987 is about 1.7 million ha, representing a 46% reduction from 1986.

## Quebec

***Defoliation*** — The spruce budworm infestation continued to decrease dramatically in all areas of Quebec in 1986. The epidemic which became acute in 1969 has shown definite signs of slowing in the last 2 years. All areas reported a more or less significant reduction in infestation, both in terms of intensity and area.

Appreciable declines in budworm populations occurred mainly in western and central Quebec, in the administrative regions of Abitibi-Témiscamingue,

Outaouais, Montreal, Trois Rivières, Quebec City, and Saguenay/Lake Saint Jean. No annual defoliation was detected in the forests of the Eastern Townships, Outaouais, and Abitibi-Témiscamingue regions, and the insect was present only at trace levels in these regions. The infestation remained particularly virulent in the North Shore Region and continued at a moderate level in several areas of the Gaspé Peninsula and the Trois Rivières Region (Figure 1).

The budworm infestation covered 2.83 million ha in 1986, compared with 9.26 million ha in 1985. Damage was light over 0.75 million ha, moderate over 1.35 million ha and severe over 0.73 million ha (Table 3). Severe damage occurred on only 26% of the total infested area in 1986, compared with 59% in 1985.

In western Quebec, the budworm declined in all areas of the Abitibi-Témiscamingue Region that were infested in 1985. The insect was present in trace amounts only, and very low numbers were reported in the area of severe infestation, which had persisted for several years around lakes Duparquet and Hébécourt. Budworm damage in that area was so light that no defoliation could be found by aerial survey.

In central Quebec, the area between the La Vérendrye and Laurentides reserves also suffered less extensive and less intense damage than reported in 1985. The budworm decreased throughout this vast area; many sectors were spared altogether in 1986, and recorded damage was significantly lower than in 1985. The infestation fell off entirely in the Outaouais Region, while a very significant decline in budworm populations was observed in the area bounded by the Mitchinamecus and Gouin reservoirs, the municipality of La Tuque, and Lake Saint Jean.

But the budworm maintained its hold over the area between Manouane, Saint Donat de Montcalm, Saint Roch de Mékinac, and La Tuque, where damage was predominantly moderate in 1986, compared with the severe damage recorded in 1985. The infestation covered a significant part of the Joliette, Mastigouche, Saint Maurice, and La Mauricie Park reserves. Defoliation was particularly severe in areas surrounding the Taureau Reservoir and along the periphery of the À la Chienne Lake dam. East of the Saint Maurice River, the budworm decline continued into the Laurentides Reserve.

Table 3. Area (ha) of spruce budworm infestation in the administrative regions of Quebec in 1986, excluding areas of mortality.

| Administrative regions | Level of infestation Light (ha) | Moderate (ha) | Severe (ha) | Total (ha) |
|---|---|---|---|---|
| Gaspé/Lower St. Lawrence (01) | 315 314 | 322 032 | 58 094 | 693 440 |
| | (953 128) | (325 740) | (275 552) | (1 554 420) |
| Saguenay/Lake Saint Jean (02) | 26 662 | 32 656 | 13 282 | 72 600 |
| | (727 451) | (70 503) | (1 196 307) | (1 994 261) |
| Quebec City (03) | 36 721 | 100 782 | 41 095 | 178 598 |
| | (958 596) | (121 209) | (575 132) | (1 654 937) |
| Trois-Rivières (04) | 274 208 | 440 980 | 81 814 | 797 002 |
| | (58 907) | (186 876) | (2 031 564) | (2 277 347) |
| Eastern Townships (05) | — | — | — | — |
| | (2 813) | — | — | (2 813) |
| Montreal (06) | 43 281 | 255 626 | 35 313 | 334 220 |
| | (16 875) | (13 594) | (372 345) | (402 814) |
| Outaouais (07) | — | — | — | — |
| | (100 626) | (37 344) | (51 250) | (189 220) |
| Abitibi-Témiscamingue (08) | — | — | — | — |
| | (1 407) | (21 251) | (10 313) | (32 971) |
| North Shore (09) | 55 558 | 199 694 | 500 835 | 756 087 |
| | (149 036) | (37 732) | (964 265) | (1 151 033) |
| Province | 751 744 | 1 351 770 | 728 433 | 2 831 947 |
| | (2 968 839) | (814 249) | (5 476 728) | (9 259 816) |

Areas affected in 1985 are shown in parentheses.
(Table: courtesy of Quebec Department of Energy and Resources)

The decline in spruce budworm populations was especially noteworthy throughout the Saguenay/Lake Saint Jean Region, in the Laurentides Reserve, and in the Charlevoix management unit. The budworm was found only at trace levels over vast areas of particularly virulent infestation in 1985, where it had increased significantly in relation to 1984. Damage observed in this sector in 1986 was infrequent, sporadic, and generally located over relatively small areas.

The spruce budworm decline which began several years ago along the south shore of the St. Lawrence continued in 1986. Population reductions were observed from the Eastern Townships to the Gaspé Peninsula. Damage was very light (trace levels) west of the Matapédia Valley, although several scattered small areas of light-to-moderate defoliation persisted, as well as one larger area south of the Lower St. Lawrence management unit, where a new upsurge was reported. Increased damage was recorded in the Rimouski Reserve, primarily in the area between lakes Rimouski and Mistigougèche, the Patapédia River, and the New Brunswick border. The budworm continued to decline east of the Matapédia Valley.

Spruce budworm damage remained significant in the centre and on the north side of the Gaspé Peninsula. The insect persisted in all areas infested in 1985 and caused moderate-to-severe damage in many areas located primarily between the Nouvelle and Cascapédia Est rivers, between the Grand Pabos, Grande Rivière, and Saint Jean rivers, in the York River basin, and in the area between the municipalities of Cap au Renard and Grande Vallée. The intensity of infestation, however, was less than that recorded in 1985.

The spruce budworm decline reported in central Quebec also extended along the north shore into the Les Escoumins and Forestville management units. Areas of severe defoliation in 1985 located between the Escoumins and Portneuf rivers were totally spared in 1986. East of the Portneuf River the infestation remained virulent as far as Port Cartier, although damage was less intense than in 1985 in certain areas between Forestville and Baie Comeau. The infestation, nevertheless, expanded between Baie Comeau and Port Cartier, and damage was generally moderate to severe. On Anticosti Island, the insect persisted in the area infested in 1985, between lakes Geneviève and Aux Cailloux; damage observed on the island in 1986 was thus confined to a very small area.

***Control*** — The Quebec Department of Energy and Resources conducted its 17th spruce budworm aerial insecticide spraying program in 1986. A total area of 51 155 ha of forest in the Trois Rivières (12 000 ha), North Shore (37 492 ha), and Saguenay/Lake Saint Jean (1663 ha) regions were treated. Spraying was far less extensive than in previous years and, for the first time since 1971, the Gaspé/Lower St. Lawrence Region was not treated.

The biological insecticide *Bacillus thuringiensis* (B.t.) was sprayed over 18 160 ha (35% of the treated area) located primarily in the Trois Rivières Region; Thuricide 48 LV® was applied at 30 BIU/ha in 2.37 L/ha. The chemical insecticide fenitrothion (Sumithion®) was used on the remainder (65%) of the treated area; the dosage used in each of two sprayings was 210 g/Al in 1.4 L/ha. Five single-engine airplanes (2 Bull Thrushes and 3 Ag-Cat Bs) carried out the spraying, which started May 29 in the Trois Rivières Region and ended July 3 in the North Shore Region.

Insecticide spraying made it possible to protect 42% of annual foliage and ony 5% of the entire treated area was severely defoliated. In addition to preventing severe defoliation of most annual growth, the 1986 spraying program served to contain the extent and intensity of residual spruce budworm infestations.

Two other spraying programs to protect private forests were conducted by the Fédération des producteurs de bois du Québec (3375 ha, paid for by the Quebec Department of Energy and Resources) and by the Canadian Forestry Service (14 629 ha).

***Forecast*** — Use of the egg mass survey to forecast population levels and damage for the following year was abandoned entirely in 1986 in favor of estimating hibernating populations. The survey to prepare that estimate, conducted in autumn in about 2000 sample plots throughout the province, showed that budworm populations will continue to decline in all regions of Quebec in 1987, with the exception of Gaspé/Lower St. Lawrence. Budworm population levels will generally be quite low in western and central Quebec (Abitibi-Témiscamingue, Outaouais, Montreal, Trois Rivières, Eastern Townships, Quebec City, and Saguenay/Lake Saint Jean). Certain residual populations will remain moderate to high in a few areas of the Montreal and Trois Rivières regions. The insect will persist over part of the area heavily infested in 1986, such as the Joliette, Mastigouche, and Saint Maurice reserves, la Mauricie Park, and certain areas southeast of La Tuque. In the Gaspé/Lower St. Lawrence, infestations, which persisted in 1986, will intensify in 1987 and, in most cases, will expand somewhat. These infestations are located south of the Rimouski Reserve, southwest of the Matapédia Valley, and in the central and northern Gaspé Peninsula. The Rivière du Loup area will be little affected by the budworm for the second consecutive year. Finally, the spruce budworm epidemic will remain intense on the North Shore, despite a slight decline in comparison with 1986; areas between the Portneuf River and Port Cartier will suffer moderate-to-severe infestation again in 1987.

## Ontario

***Defoliation*** — The total area of moderate-to-severe defoliation declined by 3.476 million ha from 12.332 million ha in 1985 to 8.856 million ha in 1986, a

decrease of about 28%. The largest declines were along the eastern edge of the main infestation in the Wawa and Hearst districts, although substantial declines were also recorded in the Thunder Bay, Geraldton, Terrace Bay, Nipigon, Dryden, and Fort Frances districts. These were partly offset by increases in the area of moderate-to-severe defoliation in the Red Lake and Sioux Lookout districts. A huge infestation still persists, however, from the Pagwa River-Marathon area of Geraldton and Terrace Bay districts west to the Manitoba border. The total area encompassed by this main body of infestation is about 7 779 065 ha. Infestations in the remainder of the province, which includes northeastern and southern Ontario, declined for the fourth consecutive year. The total area affected was approximately 48 000 ha, down from 157 145 ha in 1985.

***Damage*** — The total area of budworm-associated tree mortality now stands at 13 985 708 ha, an increase of 49 708 ha over the 1985 figure. Most of the new mortality occurred in the Fort Frances and Dryden districts, but small scattered pockets of new mortality were also mapped in the southwestern and east central Thunder Bay District. Small, new patches of mortality were also mapped in the Hearst, Geraldton, and Terrace Bay districts. In the remainder of the province where budworm populations have declined drastically over the last several years, budworm-associated tree mortality has remained unchanged.

***Control*** — The Ontario Ministry of Natural Resources increased its control program in 1986 and aerially treated approximately 147 000 ha of spruce-fir forest. This compares with about 29 000 ha in 1985. The areas treated included commercial and high-value stands such as parks, plantations, and wildlife habitat. The biological insecticide, *Bacillus thuringiensis* (B.t.) was used exclusively in four regions of the province as follows: Northwestern (168 ha), North Central (95 382 ha), Northern (39 300 ha), and Northeastern (12 150 ha).

***Forecasts*** — The 1986 egg survey revealed an overall increase of 16% in egg-mass densities. Nearly all of the increase occurred in the Northwestern Region where egg densities were about 89% above 1985 levels. Consequently, in 1987, moderate-to-severe defoliation is expected to persist in most of the area infested in 1986 with some possible expansion along the northern edge of the current infestation. Results were more varied in the North Central Region where moderate-to-severe defoliation is expected to persist in the Atikokan and Nipigon districts in most of the area affected in 1986. However, substantial declines are expected in the Thunder Bay, Geraldton, and eastern Terrace Bay districts. The most substantial declines will probably occur in the southern Thunder Bay District where the infestation may begin to collapse. Moderate-to-severe defoliation will likely persist in the Sibley Peninsula area and along the Thunder Bay-Nipigon district boundary. Increased defoliation is expected in the Black Sturgeon Lake area of the western Nipigon District and the east central Thunder Bay District.

In the Northeastern and Northern regions, egg densities were down by 89% from last year's levels, the fourth consecutive year of decline. As a result, little defoliation is expected in 1987 with the possible exception of the western Hearst District where a few scattered pockets may occur. No defoliation of any consequence is expected in southern Ontario.

## Manitoba

Moderate-to-severe defoliation by the spruce budworm in Manitoba in 1986 decreased by about 56% from that reported in 1985. Nearly all areas of infestation occurred in the southeast part of the province, with highest populations and increased area defoliated in the Whiteshell area. Total area defoliated was about 34 000 ha.

## Saskatchewan

Defoliated white spruce-balsam fir stands occurred at five locations in the east-central part of the province, and amounted to 18 500 ha, an increase of about 23% over last year. Heavy defoliation in some of these locations began as early as 1982 and 1983. In three of the main outbreak areas (Torch River, Usherville, and Red Earth), the province has undertaken salvage harvesting of stands identified to be the most severely damaged by the budworm.

## Alberta

Small infestations causing moderate-to-severe defoliation were noted at five locations within the central part of the province, amounting to 300–500 ha. Some of these infestations are located in high use areas of provincial parks and the city of Edmonton, and have been treated with B.t. for two consecutive years. In addition to the spruce budworm in the city of Edmonton, high populations of the spruce bud moth *Zeiraphera canadensis* and *Dioryctria reniculelloides* were also noted.

## Northwest Territories

In the Northwest Territories where about 12 000 ha of severe defoliation was recorded last year, the outbreaks have now expanded to about 18 000 ha, but spread over a much larger area. Much of the increases occur along the Liard River drainage and in two new areas adjacent to the Slave River. Infestations are expected to continue in 1987 based on trends of previous outbreaks.

## British Columbia

Light and moderate defoliation of white spruce and alpine fir occurred over 94 700 ha in the Fort Nelson area in northeastern British Columbia, up 13-fold since 1984 when populations first increased. Defoliation extended along the Fort Nelson and Liard river valleys to the Yukon and Northwest Territory border and in the Coal River Valley and near Liard Hot Springs, west of Fort Nelson. Populations are expected to continue in 1987 based on trends of previous outbreaks.

# Western Spruce Budworms

*Choristoneura* spp.

## British Columbia

The western spruce budworm, *Choristoneura occidentalis* Free., is the most widely distributed and destructive defoliator of coniferous forests in western North America. It is a distinctly different species from the eastern spruce budworm and, despite the common name, within British Columbia feeds primarily on Douglas-fir. Other conifer feeding budworms currently active in British Columia include the two-year cycle budworm, *C. biennis* Free.; another one-year cycle budworm, *C. orae* Free.; and the eastern spruce budworm, *C. fumiferana* (Clem.), whose range extends into northeast British Columbia.

Since 1900, at least six western budworm infestations of varying duration have occurred at irregular intervals in southern British Columbia. The effects of defoliation include loss of radial and height growth, top-kill and resulting defects, and some tree mortality. The Fraser Canyon infestation, which started in the late 1960s, peaked in 1977 with 226 000 ha defoliated. Populations then began increasing in drier interior stands from Cache Creek east and now, with more than 400 000 ha infested, it is the most expansive infestation recorded. Mortality of understory regeneration in these stands, although largely unquantified, is of greater concern than in the wetter zones previously infested.

In 1986 the area of immature and mature Douglas-fir forests in the southwestern interior of British Columbia defoliated by the one-year cycle western spruce budworm almost doubled to 413 000 ha (Figure 3). This is the most extensive outbreak recorded in British Columbia during 50 years of CFS- FIDS surveys. Most defoliated stands were in the Kamloops Region. Less extensive defoliation was recorded in the Cariboo and Nelson regions and defoliation occurred for the first time since 1981 in the Vancouver Region.

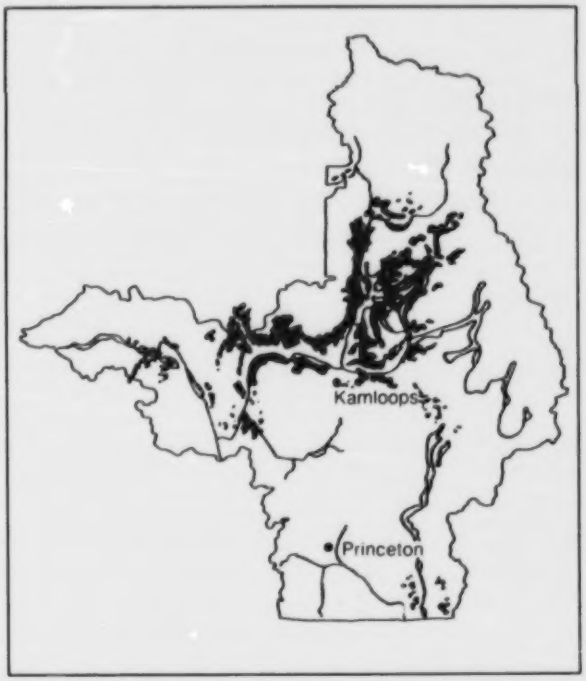


**Figure 3.** Areas of western Canada where defoliation by the western spruce budworm was detected in 1986.

The major expansion occurred in Kamloops Region with 80% of the total infested area lightly defoliated, 18% moderate, and 2% severe. Major expansions occurred to the northern limits of the host range near Avola in the North Thompson River Valley and around Falkland, Westwold, Salmon Arm, Chase, and west of Osoyoos to near Summerland. Light defoliation occurred for the second consecutive year and expanded along the north shores of Anderson and Seton lakes and the south side of Carpenter Lake west of Lillooet.

The area of Douglas-fir in the Nelson Region that is mainly affected by light defoliation expanded from 60 ha to 3700 ha between Rock Creek and Anarchist Mountain. Pockets of Douglas-fir at Johnston Creek east of Anarchist Mountain have been defoliated to varying degrees for about 9 successive years.

Light and moderate defoliation of the current year's foliage occurred in the Vancouver Region for the first time since 1981 over about 1250 ha in the Blackwater Creek drainage near D'Arcy. The last major outbreak in the Vancouver Region started in this area in 1970 and continued until 1980.

In the southern part of the Cariboo Region near Clinton, budworm populations declined due to young larvae mortality caused by below normal temperatures in the late spring. This resulted in no visible defoliation where Douglas-fir had been moderately

or severely defoliated over 29 500 ha in 1985. In the eastern part of the region, however, half the current year's needles on Douglas-fir and some alpine fir were very lightly defoliated for the first time in recent years over 180 ha in five pockets near Mahood Falls and Bowers Lake.

As a first approach to tree condition assessment, the FIDS aerial sketch maps for the last 6 years were compared by computer overlays. Of the total area infested to date, most (66%) had been visibly defoliated 1 year, with 26% defoliated for 2 consecutive years, and 7% for 3 consecutive years. Less than 1% of the total area had received either 4, 5, or 6 years defoliation.

Larval mortality was 44% in an interagency experimental spray trial which applied *Bacillus thuringiensis* over about 200 ha of newly infested Douglas-fir in Paul Lake Provincial Park near Kamloops. Rainfall both before and after application and advanced larval development may have reduced efficacy.

Mortality of understory trees is evident but variable (0, 8, and 95%) in three stands defoliated for several years. Preliminary assessments of moderately and severely defoliated mature trees averaged 6% Douglas-fir mortality in 38 of 63 plots and none in the remainder. There was no mortality of trees in plots with up to 2 years of defoliation, but tree mortality of 1.2% and 4.6% occurred after 3 and 4 years of defoliation, respectively.

Parasitism of early and some late instar larvae occurred at 39 of 41 stands, mainly in the Kamloops Region, but averaged only 8% (range 0 to 50%), down from 11% in 1985, and is too low to effectively reduce populations.

Egg sampling at 54 locations in four forest regions forecasts severe defoliation at 72% of the areas throughout the Kamloops Region and in adjacent parts of the Nelson and Cariboo regions. Light or moderate defoliation is predicted mainly near D'Arcy in the Vancouver Region and in isolated parts of the other three regions. Additional sampling by the B.C. Forest Service in the Kamloops and Nelson regions indicates similar levels of expected defoliation. Light defoliation is forecast to continue in the southern part of the Cariboo Region near Mahood Falls.

Pheromone-baited sticky traps were used to monitor male adult populations in six Douglas-fir stands in the Kamloops and Vancouver regions, and catches averaged 5 to 117 adults per trap. This indicated the budworm's presence, but numbers cannot yet be correlated with population potential and damage. More effective nonsaturating traps were also tested for a second year since sticky traps were discontinued in most areas. Results are pending.

Defoliation by two-year cycle budworm *C. biennis* of current alpine fir and white spruce foliage was mostly light over 60 000 ha in the Cariboo, Kamloops, and Prince George regions. This was more than a fourfold increase from 1984, the last year of mature larval populations. Increased populations were present in isolated pockets in the Nelson Region, but populations remained low in previously active infestations in the Prince Rupert Region.

Identification and life cycles of spruce-fir budworms in northern British Columbia continue to be studied by taxonomists at the Biosystematics Research Centre, Ottawa; Great Lakes Forestry Centre, Sault Ste-Marie; and Pacific Forestry Centre, Victoria.

## Western Blackheaded Budworm

*Acleris gloverana* (Wlshm.)

### British Columbia

Western blackheaded budworm has caused extensive defoliation, top-kill, and some tree mortality in western hemlock forests in British Columbia periodically since the 1940s. Infestations occurred in coastal forests of all ages on northern Vancouver Island or the Queen Charlotte Islands in the mid-1940s, 1950s, and early 1970s. Flareups have occurred in interior, usually over-mature, wetbelt forests in the mid-1950s, 1960s, and 1980s, but these have subsided without appreciable damage.

In 1986 increased blackheaded budworm populations defoliated mainly mature and some immature western hemlock over 56 200 ha on the Queen Charlotte Islands and near Kitimat in the second year of this outbreak. Populations collapsed, however, over 2150 ha west of Harrison Lake in the Vancouver Region and in 12 500 ha of old growth hemlock in interior British Columbia.

The major increase, as predicted, occurred on the Queen Charlotte Islands with 44 300 ha defoliated (31% lightly, 57% moderately, and 12% severely) up from 28 600 ha of mainly moderate defoliation in 1985. Near Kitimat the area of mainly moderate defoliation expanded more than fivefold to 11 900 ha. Most (75%) of the stands defoliated were 100 years older, 19% were 20–100 years with only 6% less than 20 years.

A greatly reduced population is forecast for most areas in 1987, based on the reduced number of eggs. Trace or light defoliation is predicted for 25 sites including the southern end of Moresby Island, Lyell Island, and Kitimat, with moderate defoliation at eight sites including the north end of Moresby Island and parts of Masset Inlet and Louise Island.

Larval parasitism in three areas averaged 16% (range 2–23%), not high enough to significantly

reduce populations. Diseases, weather, and starvation are natural factors which contribute significantly to population collapses.

Following 2 successive years of severe defoliation, 12% mortality of second growth hemlock occurred in representative plots over 3100 ha on the Queen Charlotte Islands and top-kill averaged 8 m on 75% of the surviving trees. In 4400 ha of moderately defoliated second growth, top-kill averaged 4 m on half the trees and 80% of the moderately to severely defoliated mature hemlock over 18 700 ha averaged 3 m of top-kill.

Based on 15 dominant or codominant western hemlock cut shortly after the last blackheaded budworm infestation at Jeune Landing on northern Vancouver Island, average radial growth from 1972 to 1974 was 69% less than pre-infestation growth, and during recovery (1975–76) still only averaged 55% of previous rates. The trees averaged 28 years at breast height and defoliation among trees ranged from 42 to 82%. Similar growth loss may be expected in this outbreak.

## Jack Pine Budworm

*Choristoneura pinus pinus* Free.

This close relative of the spruce budworm has long been regarded a serious pest of jack pine stands and plantations in northwestern Ontario, Manitoba, and Saskatchewan, and in the Lake states of the U.S.A. Only in recent years (1967–72) have destructive populations also occurred in central and eastern Ontario and Quebec. Tree mortality of up to 30–40% of the jack pine component in a stand may occur following 2 to 3 years of moderate to severe defoliation. Top killing is common also and may result in half or more of the stand being damaged.

### Ontario

***Defoliation*** — As a result of major population declines, the area of moderate-to-severe defoliation decreased from 3 660 069 ha in 1985 to 1 743 725 ha in 1986, a reduction of about 53% (Figure 4). Much

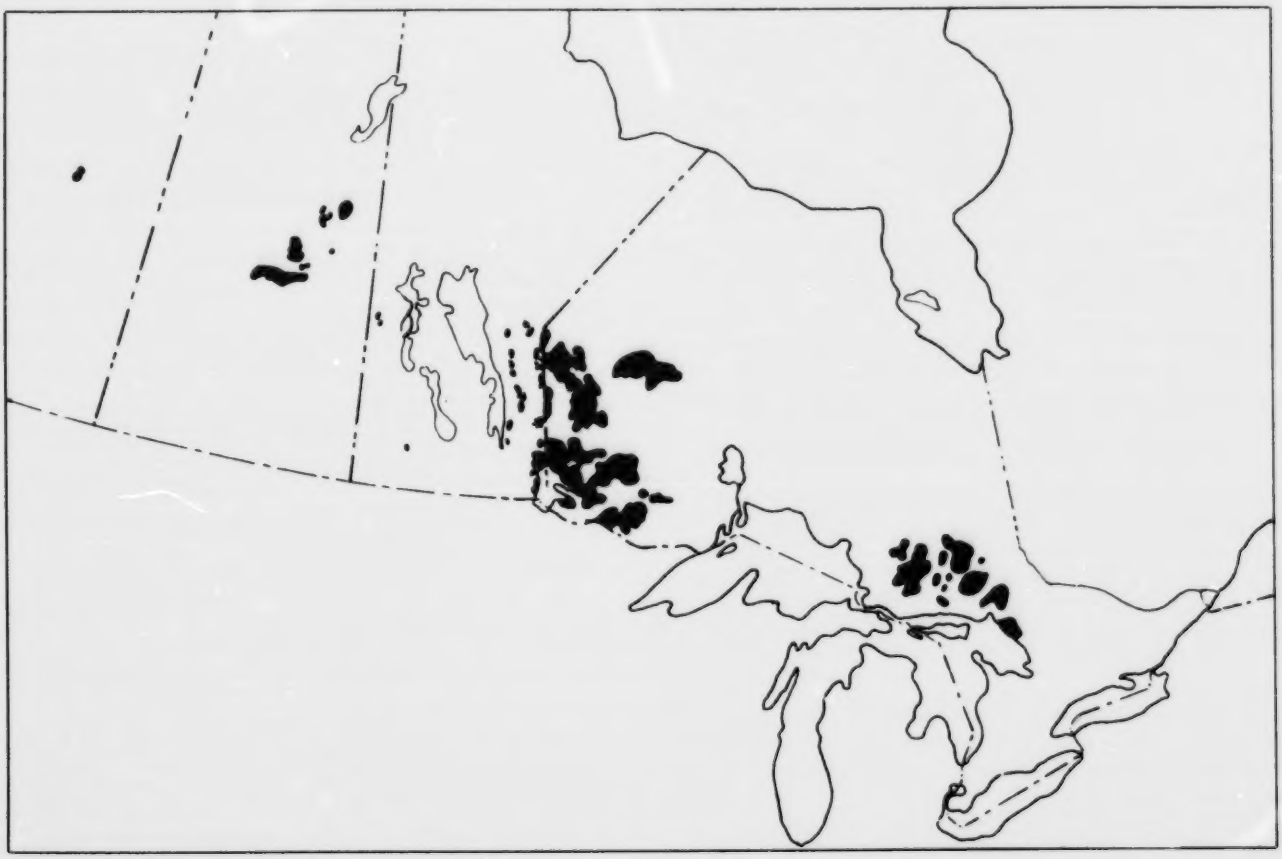

**Figure 4.** Areas of moderate-to-severe defoliation by the jack pine budworm.

of the reduction occurred in the Northern and Northeastern regions where 150 096 ha of moderate-to-severe defoliation were mapped in 1986 compared with 1 842 811 ha in 1985. A large part of this (70 107 ha) was located in a single infestation on the Chapleau-Blind River district boundary. The remainder consisted of small pockets scattered throughout the Chapleau, Gogama, Blind River, Espanola, Sudbury, and North Bay districts. In the Parry Sound District of the Algonquin Region, moderate-to-severe defoliation declined from 54 000 ha in 1985 to 8100 ha in 1986, most of which was located along the Georgian Bay coast. Infestation in the North Central Region virtually collapsed with only one area persisting. This consisted of 31 000 ha of moderate-to-severe defoliation in the northwest corner of the Atikokan District, which was part of a larger infestation stretching into the Fort Frances, Dryden, and Ignace districts of the Northwestern Region.

The Northwestern Region was the only exception to the general trend of decline as 1 554 139 ha of moderate-to-severe defoliation were mapped in 1986, an increase of about 76 000 ha over the previous year's figure. In addition to the defoliation described above, over 800 000 ha of moderate-to-severe defoliation recurred in the Red Lake District along with 315 000 ha in the Kenora District. Over 90 000 ha of new, moderate-to-severe defoliation were mapped in the Wendigo Lake area of Sioux Lookout District along with 133 653 ha in Dryden District and 99 391 ha in Fort Frances District.

***Damage*** — Damage was evidenced by top-kill, and tree mortality was most pronounced in the Chapleau and Gogama districts of the Northern Region. Here, a total area of 8 666 ha was affected with counts averaging 1.4% tree mortality and 23.9% top-kill. Damage in the Northeastern Region consisted of scattered pockets of whole tree and top mortality with counts at 14 locations averaging 6% whole tree mortality and 6.3% top-kill. In the Northwestern Region the most severe damage was located in the Kenora and Fort Frances districts where a total of 2 480 ha were affected. Most of the damage was inaccessible but at one location near the town of Redditt, Kenora District, whole tree mortality stood at 1% along with 37% top-kill. In the Red Lake District, very sporadic, small pockets of mortality were recorded in several areas and counts of nine locations revealed an average of 7% mortality and 12% top-kill.

***Control*** — The Ontario Ministry of Natural Resources carried out aerial spraying operations on a total area of 493 000 ha. The bacterial insecticide *Bacillus thuringiensis* (B.t.) was used exclusively to treat jack pine stands in four regions as follows: Northwestern (173 400 ha), North Central (67 600 ha), Northern (61 000 ha) and Northeastern (191 000 ha).

***Forecast*** — Egg surveys were carried out at 389 locations across the province in late July and August. An analysis of the results, including 44 samples from sprayed areas, shows an overall decline of 54% in egg densities. In northwestern Ontario, declines of 44%, 48%, and 22%, respectively, were recorded in the Fort Frances, Red Lake, and Sioux Lookout districts. The probable result is that widespread population reductions and possible infestation collapses are likely in these areas in 1987. In Dryden, Ignace, and Kenora districts, egg counts increased by 60%, 52%, and 27%, respectively. However, it is expected that increased pressure from parasites, reduced jack pine flowering, and other natural control factors will reduce defoliation to light and occasionally moderate levels. Most of this defoliation will occur in previously infested areas in the Kenora and western Dryden districts, in the western Fort Frances District, and at the adjoining corners of the Fort Frances, Dryden, Ignace, and Atikokan districts. In northeastern and southern Ontario, collapsing populations combined with egg count reductions ranging from 67% to 90% indicate that defoliation in 1987 will be insignificant.

## Quebec

The jack pine budworm, which has caused significant damage in northeastern Ontario in recent years, was monitored closely in 1986. Careful research uncovered larvae in 10 natural jack pine stands and 2 plantations in the Abitibi-Témiscamingue Region, as well as in one natural stand in the western part of the Saint Maurice Reserve.

A network of 60 pheromone traps was installed on 15 sites along the Quebec-Ontario border in the Abitibi-Témiscamingue Region (10 sites), on Grand Calumet Island (2 sites), and in the area of the Baskatong Reservoir (3 sites).

The purpose of this project is to determine the feasibility of establishing a permanent jack pine budworm detection network at a time when population levels of this insect are endemic. The specific objectives for 1986 were to determine the presence of the insect in Quebec and to verify the effectiveness of two types of traps in capturing male moths.

Results indicate that the insect is present throughout this part of Quebec because male moths were captured in 13 of the 15 sample sites. The number of captures was very low, however, averaging 2 to 3 moths per site, with the exception of a site near Fort Coulonge, where 26 moths were captured.

Two types of traps were evaluated. The Multi-Pher and the Multi-Pher 3 are distinguished by the shape of the opening through which moths may enter the trap. The Multi-Pher 1 has a rectangular opening and the Multi-Pher 3 has a circular opening.

Despite the small number of captures, these two trap types seem to be of comparable efficiency

because the same number of moths were harvested in both traps on the five sites selected for this evaluation. Such testing must be continued, however, before a trap type is selected.

### Manitoba

Moderate-to-severe defoliation of jack pine in Manitoba, caused by the jack pine budworm was mapped over some 132 000 ha distributed mostly in the southeastern part of the province (Figure 4). This represented a decrease of over 90% for the areas mapped last year. Declines occurred in most areas except in the Lake Winnipeg East and Pineland districts, while intensification occurred in the Whiteshell area.

### Saskatchewan

Moderate-to-severe defoliation of jack pine occurred in six general areas and increased to about 176 000 ha, indicating a 35% increase over last year. Some decline in area of infestation occurred in east central Saskatchewan while increases were noted in the central region.

### Alberta

The outbreak in Alberta remained similar to last year, involving a few hectares of moderate-to-severe defoliation in the central part of the province.

### Maritime Provinces

Jack pine budworm was an insect of no consequence in the Maritimes in 1986. It was not reported from either Nova Scotia or Prince Edward Island. In New Brunswick, jack pine budworm was present in a few plantations, mostly in the eastern half of the province, and caused only up to 10% defoliation except in one plantation in Kent County where moderate defoliation occurred.

## Mountain Pine Beetle

*Dendroctonus ponderosae* Hopk.

Mountain pine beetle continues to be the most damaging forest insect in British Columbia and, to a lesser degree, in Alberta. Mature lodgepole pine are by far the most commonly affected trees, followed by western white pine, occasionally ponderosa pine and other pines, and rarely other species. Outbreaks have been recorded at varying geographic locations within British Columbia and Alberta at irregular intervals since at least 1910. The current outbreaks started during the late 1960s and early 1970s. The area of newly red trees (attacked the previous year and often called faders) increased each year with very rapid increases in the early 1980s. Cumulatively, well over 185 million mature pine have been killed and harvesting plans throughout British Columbia have been severely impacted.

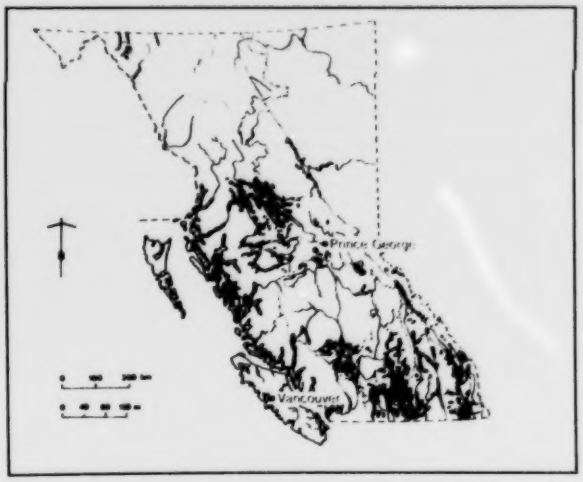


**Figure 5.** Areas in British Columbia where mortality by the mountain pine beetle occurred in 1986.

### British Columbia

Recent tree mortality caused by mountain pine beetle in 1986 in British Columbia declined for the second consecutive year but still covered more than 94 100 ha, about six times the area burned by forest fires (Figure 5). More than 8500 active infestations extending from the International border south of Cranbrook to north of Terrace contained about 3.5 million $m^3$ of mature lodgepole pine and some western white pine killed by 1985 beetle attacks. An additional 228 000 ha of mature pine forests in the Cariboo and Kamloops regions contained trees that has been killed 2 or more years ago. The most significant decline occurred in the Cariboo Region where below normal temperatures in late 1984 and 1985 killed almost all beetle populations. Elsewhere, however, areas with pine killed by the beetle more than doubled in the Nelson Region to 28 000 ha; increased about 20% to 14 000 ha in the Prince Rupert Region, and to 1 225 ha in the Prince George Region, but remained similar to 1985 in the Kamloops and Vancouver regions.

In the Cariboo Region mountain pine beetle attack averaged less than 2% in 1985 cruises and with "pitch-outs" and overwintering mortality, the number of recently killed pine is even lower. Because of the great reduction in attacks and because of harvesting and control operations, pine mortality in this region is expected to be greatly reduced in 1987.

Infestations in the Nelson Region covered 28 000 ha

and included 1.2 million (448 500 $m^3$) lodgepole pine and some white pine in 3300 infestations. The more than twofold increase was mainly in the West Kootenay and to a lesser extent near Cranbrook and Invermere. Infestations on the western edge of Kootenay National Park increased slightly but generally declined along the B.C.-Alberta border due to elevation, weather, and harvesting.

The area containing mature lodgepole pine killed by 1985 attacks in the Prince Rupert Region increased to 14 000 ha, which contained 946 000 trees (689 000 $m^3$) mainly in the western part of the region. Outbreaks continued in Harold Price Creek, in the Nass, Cranberry, Kispiox, and Nilkitkwa river drainages and in the Skeena River Valley west of Hazelton to Terrace.

Mortality of mature lodgepole pine in the Prince George Region increased 16% to 1 225 ha, mostly in the Fort St. James area. In Mt. Robson Provincial Park near the B.C.-Alberta border only 26 pine were found attacked in 1986 following a successful interagency control program in which 259 beetle-infested pines were cut and burned in 1985. Host depletion and harvesting contributed to a further decline in the number of western white pine killed by the beetle south of Valemount in the Canoe Arm area.

The area containing recent tree mortality in the Kamloops Region increased slightly to 47 900 ha. There were 2165 infestations, which contained 4.8 million trees (2.3 million $m^3$), in stands east and west of the Okanagan Valley and west of Lytton and Lillooet. Within the infested area, trees killed in or prior to 1984 occurred over an additional 38 000 ha.

The number of infestations in the Vancouver Region increased to 190 but the area, 4 160 ha, was similar to 1985 and contained 127 000 trees (101 500 $m^3$). Most infestations were in the remote Homathko River drainage just west of extensive outbreaks in the Cariboo Region. The number of beetle-killed trees in the eastern part of Manning Park declined slightly, largely because of a control program in its fifth consecutive year.

Assessments of overwintering broods in the spring of 1986 showed that sufficient numbers survived to continue to threaten susceptible mature lodgepole pine in four regions and confirmed declines in the Cariboo Region. This was borne out by the distribution of new attacks during the summer. In 52 representative mature pine stands surveyed, the incidence of current attack averaged 11% of the trees, down from 17% in 1985. Tree mortality in 1987 will vary greatly among stands and regions. The average current attack was highest in the Prince Rupert Region at 32%, 10% in the Nelson Region, and lower in other regions. In the Cariboo Region the only observed mountain pine beetle attack was associated with pheromone-baited trees. Engraver beetles, *Ips* spp. have increased, however, attacking about 2% of the trees, half of which had previously but unsuccessfully been attacked by mountain pine beetle.

Salvage and control operations were less severely affected by the depressed lumber markets of recent years but industry shutdowns in some areas contributed to the problem of beetle-killed timber exceeding mill capacities. In the third year of a special protection program, the B.C. Forest Service allocated $8.2 million towards road construction to extract threatened timber, cut and burn, or chemical treatments using MSMA, to reduce the spread of dark beetles, and aerial and ground surveys and pheromones for monitoring and restricting beetle dispersal.

## Alberta and Saskatchewan

Infestations of the mountain pine beetle continued to decline in southwestern Alberta and Saskatchewan and in the Rocky Mountain National Parks, except in Kootenay and Yoho national parks. Estimates of 130, 10, 5500, and 55 new fader trees were reported in Yoho, Banff, Kootenay, and Waterton Lakes national parks, respectively. The largest increase occurred in Kootenay National Park where there was a near twofold increase over last year. Good overwintering survival and readily available mature lodgepole pine trees largely contributed to the increase.

Elsewhere in southwestern Alberta where the main infestation has persisted, only a few scattered lodgepole and limber pines were attacked, while virtual collapse seems apparent in the Cypress Hills area on the southern Alberta/Saskatchewan border.

Intensive detection and control programs on the beetle were carried out by provincial forestry and park staff in both Alberta and Saskatchewan, and involved the deployment of commercially-prepared pheromone lures and sanitation cuttings.

The Mountain Pine Beetle Interagency Committee involving CFS, Parks Canada, B.C. Ministry of Forests, B.C. Parks, and Alberta Forest Service met to review infestations on or adjacent to the Alberta-B.C. border, and to discuss control proposals. Considerable focus was on infestations west of Jasper National Park, west of the Kananaskis area, and in Kootenay National Park.

The Border Lodgepole Pine Management Coordinating Group formed under the Mountain Pine Beetle program of the Canada/USA Memorandum of Understanding met in the Kelowna area of B.C. to view and discuss bark beetle control, stand management strategies, and related land use issues such as recreation, cattle grazing, and watershed management.

## Spruce beetle

*Dendroctonus rufipennis* (Kby.)

The spruce beetle belongs to a genus of bark beetles that periodically cause significant mortality to the conifer forests of Canada. It infests all species of spruce in Canada with white spruce and Sitka Spruce as the primary hosts. The annual mortality attributable to the spruce beetle is difficult to determine because much of the mortality, except for outbreaks, originates from single or small groups of trees scattered throughout the forests. Populations are normally endemic in forest debris and overmature timber, however, stand disturbances such as blowdown, cull, or right-of-way logging operations create breeding material which facilitates population build-up. Under outbreak conditions, attack can occur on pole-size, immature timber, and atypical hosts such as lodgepole pine when these are mixed with the primary hosts.

### British Columbia

Although the spruce beetle was active in all six forest regions, the area and volume of mature white and Engelmann spruce killed by spruce beetle in British Columbia declined for the fourth consecutive year to about 300 infestations over 3 800 ha. Most of the recent beetle-infested stands were in remote areas in the Kamloops Region. Significant declines occurred in the Cariboo, Prince George, and Prince Rupert regions due to salvage and sanitation, host depletion, and below normal temperatures in late 1984 and 1985. Brood mortality in standing and windthrown spruce in parts of the Prince Rupert Region averaged 70% (range 40–95%) with only low populations remaining, mainly in butts of standing trees.

Areas of recently killed spruce in the Kamloops Region increased for the third successive year to 2 100 ha, more than double the area recorded in 1985. Infestations mapped for the first time this year in the upper Tulameen River drainage west of Princeton and along Noel Creek south of Gold Bridge contributed to the increase. Infestations at Connel, Whitecap, and McGillivray creeks north of Anderson Lake decreased by about 20%. Infestations are expected to continue in 1987 with some reduction by harvesting in the Princeton and Gold Bridge areas.

The significant decline in area and number of recently killed mature spruce in the Prince George Region was due largely to harvesting and brood mortality, leaving only about 150 ha of infested stands mostly in the McGregor and Bowron river drainages.

In the Prince Rupert Region most tree mortality, totalling 950 ha, was in remote parts of Kispiox River Valley and in the Telkwa area where populations are expected to continue and mature in 1988. About 20 mature spruce were lightly attacked by the beetle in pockets along the Haines Road between the Yukon and Alaska border in northwestern British Columbia. In 1983 about 300 beetle-infested spruce near the recently constructed road were removed or felled and peeled.

Potentially increasing populations in and adjacent to a recent salvage and harvesting operation near the south boundary of Glacier National Park in the Nelson Region were treated by cutting the infested trees into short lengths to accelerate drying. Elsewhere in the Nelson Region, infestations declined to only 40 ha in four pockets in the East Kootenay.

Most tree mortality in the Cariboo Region was limited to 240 ha in the northeastern part of Bowron Lakes Provincial Park and had occurred in 1985 or earlier.

In the Vancouver Region infestations southeast of Rivers Inlet expanded to 325 ha. Infested stands were harvested in the Fraser Canyon area and populations remained at low levels at Phantom Creek on Graham Island, one of the Queen Charlotte Islands.

The province-wide trend of the decline is expected to continue in 1987. However, broods are expected to persist in most regions at endemic levels in stumps, slash, and decked logs, and in standing trees in parts of the Prince Rupert Region. In the Walcott area 42% of the green standing trees in a cruise strip were attacked in 1986 by beetles which emerged from 1984 windthrow. This high incidence is very localized as windthrow in most parts of the region has been salvaged.

Timely treatments of developing infestations have contributed to the overall population decline. Portions of the B.C. Forest Service's special bark beetle fund have been allocated for ground surveys, trap tree programs, and windthrow examinations.

### Alberta

Spruce beetle populations have remained at low levels during the past 2 years throughout Alberta. No new major infestation has been located by the continuous monitoring program initiated throughout the areas of previous infestation and in high hazard-rated stands. Large areas of infested stands have been logged over the past 2 years and a control burn program was completed in one of these logged areas. In areas with endemic populations along the Peace River between Garden Creek and Jackfish River in northern Alberta, a few new fader trees (beetle-attacked trees) were identified in blowdown and dying spruce around the periphery of the 1986 lodgepole oil well blowout site in central Alberta.

Pheromone baiting tests for the spruce beetle conducted in 1986 show some promising results that

warrant further field trials for population monitoring in 1987.

### Maritime Provinces

Spruce beetles remained active throughout the region in 1986 and white spruce mortality occurred in all three provinces. However, the downward trend in populations and in the number of newly attacked trees, reported annually since 1984, continued in most areas.

In New Brunswick, spruce beetle damage was reported in 1980 after a 50-year period of inactivity. Since then the insect has been found in a number of widely separated areas, mostly in the southeastern and northwestern parts of the province. In 1986, there was an increase in beetle activity and further tree mortality resulted in Fundy National Park, Albert County, and on Grand Manan Island, Charlotte County. In one area along the Whistle Road on Grand Manan Island, only 12% of the mature white spruce trees remain healthy, 52% having been killed by the beetle, while 36% are attacked but still alive. Current infestations have also been observed in Westmorland, Restigouche, and Northumberland counties.

In Nova Scotia, Cape Breton Island constituted the major outbreak area during the early part of the 1980s and by the end of 1983, no large areas remained without severe white spruce mortality. Beetle activity decreased in 1984 and in 1985. In 1986 a further reduction in newly attacked trees was observed although spruce beetle-affected trees are still a common sight. More than half of the merchantable white spruce volume is now dead on Cape Breton Island as the result of the outbreak. On the mainland, there was an increase in spruce beetle-attacked white spruce trees in some parts of Pictou and Antigonish counties in 1986.

In Prince Edward Island, spruce beetles killed an estimated one-third of the merchantable white spruce by 1983 when infestations peaked. Populations have decreased steadily since that time and in 1986 only a very few newly infested white spruce trees were observed at six scattered locations in the province.

## Eastern larch beetle

*Dendroctonus simplex* LeC.

This insect normally attacks only weakened, damaged, or recently felled host material. However, when populations are very high, the insect can also attack living, apparently healthy, mature or over-mature trees. Even younger, small diameter trees can become infested.

### Maritime Provinces

In the Maritimes, a population buildup was first noticed in Nova Scotia in 1976. This increase in beetle populations followed several years of severe defoliation of larch by the larch sawfly, *Pristiphora erichsonii* (Htg.). Since then, the beetle has become widespread in all three provinces and has caused serious tree mortality. By the end of 1981, an estimated 24% of merchantable-size larch was dead in New Brunswick, 64% in Nova Scotia, and 13% in Prince Edward Island. The insect populations have been generally declining since 1984 and the number of trees succumbing to beetle attack has also decreased in most areas.

In 1986, newly attacked larch trees were observed in York and Carleton counties in New Brunswick and in a few areas in Prince County, Prince Edward Island.

At the central New Brunswick research plot, there was an increase in newly infested trees, in contrast to the general downward trend, as 6.7% of the trees were attacked, compared to 2.8% in 1985, 3.8% in 1984, and 2.9% in 1983. Cumulative larch mortality due to attack by the eastern larch beetle has increased to 34% in 1986 from 6% in 1979, when the plot was established with an average of 4.3% annual tree mortality.

## Gypsy moth

*Lymantria dispar* (L.)

The gypsy moth has been the most destructive insect of hardwoods and to a lesser degree of conifers for decades in the northeastern United States. Female moths are flightless, limiting the spread of this pest to dispersal of the minute early instar larvae on air currents or to artificial transport as eggs or larvae on human conveyances.

Trapping male moths with pheromone traps has become a common practice throughout Canada. Trapping information is used to help detect the gypsy moth and define where local populations may be found and where to search for other life stages.

### Newfoundland

A survey was made in cooperation with the Plant Health Division of Agriculture Canada. Pheromone traps were placed in camping sites, parks, and near towns to catch any female moths that may be introduced to the Island on camper vehicles. Only male moths have been caught in these traps.

## Maritime Provinces

The gypsy moth was first detected in New Brunswick in 1936 and was successfully treated then. Since its reappearance in the Maritimes in 1981, the gypsy moth has continued to expand its area of infestation, spreading further in 1986. It is now considered, at least, temporarily established in both New Brunswick and Nova Scotia.

Gypsy moth has been the most destructive insect of hardwoods and to a lesser degree of conifers in the northeastern United States for decades. The status of the outbreak in Maine in the last few years has been a special concern because of its proximity to the Maritimes Region.

The gypsy moth monitoring committee remained active in 1986, and again coordinated all surveys. This committee was formed in response to the discovery of gypsy moth in 1981, in an effort to use available personnel more efficiently in combating this latest threat to the forests of the region. Organizations involved in surveys included the Forest Insect and Disease Survey of the Canadian Forestry Service, Parks Canada of the federal Department of Environment, the Plant Health and Inspection Branch of Agriculture Canada, New Brunswick Department of Natural Resources and Energy, New Brunswick Department of Agriculture, New Brunswick Department of Tourism, Recreation and Heritage, Nova Scotia Department of Lands and Forests, Nova Scotia Department of Agriculture, Prince Edward Island Department of Energy and Forestry, and numerous municipalities. Many volunteers, campground operators, small woodlot owners, Christmas tree growers, students, and other interested private citizens also assisted in the pheromone trapping program.

In 1986, early season egg-mass surveys, larval surveys, adult trapping program, and late-fall egg mass surveys were conducted to determine the current status of the insect in the region.

The adult male trapping program is aimed at defining areas where searching for egg masses should be concentrated. As a result of studies since 1980, the trap placement design was changed in 1983 to eliminate, or at least to minimize, interference from large numbers of male moths brought into the region by weather fronts from infested areas in the United States. Information was obtained from 2869 traps: 1489 in New Brunswick, 1104 in Nova Scotia, and 276 in Prince Edward Island. Better understanding by cooperators of the value of negative results greatly aided the planning of the fall egg mass surveys.

The status of the gypsy moth in the Maritimes in 1986 follows:

In New Brunswick, gypsy moth egg masses or pupae were found at 13 locations in Charlotte and southern York counties and in Fredericton in central York County. Gypsy moth had been found previously at six of the 10 positive locations in Charlotte County. The new locations, Baillie Settlement, Anderson Settlement, Pleasant Ridge, and Moores Mills, represent a northeastern spread of gypsy moth from the previously affected areas. In York County, the two new locations, McAdam and Woukichegan Lake, represent an inward extension which apparently coincides with the northward extension of the gypsy moth in the state of Maine. The number of egg masses are low in all areas and no noticeable defoliation occurred anywhere in the province. The suspect area near Peel, Carleton County, was searched thoroughly and subjected to an extensive pheromone trapping program but no sign of gypsy moth (save for a small number of male moths) was found in 1986.

In Nova Scotia, gypsy moth was found at all locations in eight of the nine counties in the western half of the province. All but one of the areas were either the same or adjacent to areas where the insect has been found in previous years. The exception was Canadian Forces Base Greenwood, Kings County. This find represents a minor extension in distribution. In addition to CFB Greenwood, egg masses were found at two other Canadian Forces Bases, at CFB Shelburne and at CFB Cornwallis, both immediately adjacent to previously known infestations. An egg mass found for the first time in Queen's County, in Kejimkujik National Park, was very close to an area near the county line where gypsy moth was found previously. Egg masses were not numerous in most areas, except at New Minas, Bridgewater, and Shelburne but even there noticeable defoliation did not occur in 1986. It is worth noting that, in spite of extensive searching, gypsy moth was not found in several areas, most notably Yarmouth, where egg masses were present in previous years.

In Prince Edward Island, the gypsy moth has not been found yet.

The results of gypsy moth surveys, other than adult trapping programs, conducted from 1981 to 1985 are shown in Figure 6. In New Brunswick most of the gypsy moth locations are in forested areas, away from habitation and are concentrated in a small section of the province adjacent to an area of the United States where the insect is known to be present. In Nova Scotia almost all of the infested spots are inhabited areas with considerable movement of people. This suggests that whereas in New Brunswick the presence of gypsy moth, in most places, may be the result of natural spread, in Nova Scotia the insect was likely imported by tourists or residents travelling in gypsy moth infested areas.

Control operations against the gypsy moth in 1986 included a trap-out (mass trapping) program in Fredericton in which about 650 traps were placed in the infested part of the city, accompanied by extensive searching and destruction of egg masses

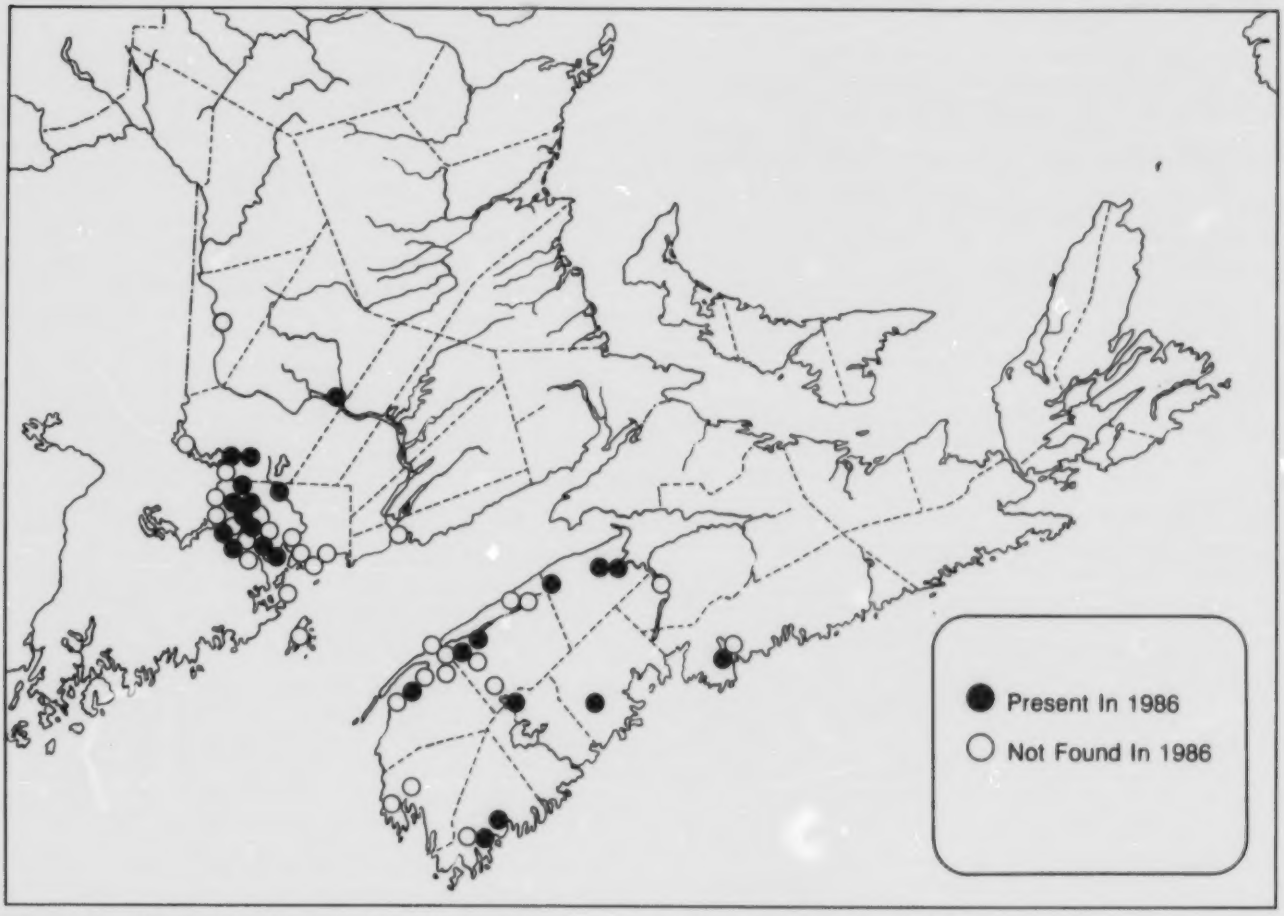


**Figure 6.** Survey locations and results for life stages other than male moths of the gypsy moth.

in advance of egg hatching. Egg mass destruction is carried out routinely during surveys whether these are for the purpose of detection or control, except in the Mohannes area in Charlotte County, New Brunswick, where egg masses are used in a parasite recovery study. Several communities became involved in public awareness programs emphasizing citizen participation in combating this newly arrived pest.

## Quebec

Gypsy moth populations increased considerably this year in the Outaouais region. This insect consolidated its hold over the areas it infested in 1985 and continued to expand its distribution westward. The insect was also found along the St. Lawrence River, from the Ontario border to La Pérade.

The gypsy moth was particularly active in 1986 along the Ottawa River, between the municipalities of Calumet, Notre Dame de la Salette and Eardley, respectively located east, north and west of Gatineau Park (Figure 7). Heavy damage was reported between Calumet and Thurso for the second consecutive year, and new areas of infestation appeared near those recorded in 1985. One of these new sites, located near Ripon, suffered 100% defoliation over about 30 ha. Several small stands of red oak in the vicinity of Papineauville and Montebello also suffered 100% defoliation. Aerial and field surveys uncovered about 30 infested areas with severe defoliation, 20 with moderate defoliation, and 10 with light defoliation. In relation to the overall surface area surveyed by air, it is estimated that approximately 2 300 ha were severely defoliated, 2 400 ha were moderately defoliated and 500 ha had suffered light defoliation. The main species affected in this sector were red oak and white oak. Trembling aspen, largetooth aspen, basswood, and sugar maple also suffered defoliation.

Further east, an upsurge in gypsy moth populations was recorded between Rigaud, Vaudreuil, and Coteau du Lac. Rigaud Mountain was particularly affected in this district; total defoliation was observed over an area of about 10 ha in which affected species were red oak, red maple, and white pine. Near Oka,

a small stand of red oak suffered severe damage.

On the north shore of the St. Lawrence, gypsy moth populations regressed between Berthierville and La Pérade. Not far from Sainte Marcelline de Kildare, northwest of Joliette, however, two areas of infestation were uncovered, and red oak trees suffered severe defoliation over an area of slightly more than 50 ha.

On the south shore of the St. Lawrence River, the insect was found at reduced population levels in areas where its presence has been known for several years. Gypsy moths were found near the municipalities of Longueuil and Saint-Hubert, along the Richelieu River, near Granby, Drummondville, and Victoriaville. Affected sites were small and defoliation did not exceed the moderate level. Trembling aspen was the primary affected species. These results are corroborated by those obtained by the Laurentian Forestry Centre (LFC), which conducted, in cooperation with the Plant Protection Division of Agriculture Canada, a survey of male gypsy moths, using pheromone traps, between Mont Saint Bruno and Quebec City. Captures declined significantly in 1986 (average 15.6 moths per trap in 1986 compared with 31.5 in 1985 in the Saint Antoine de Tilly/Inverness and Victoriaville/Lotbinière areas).

Results of an egg-mass count on 43 sites which suffered significant gypsy moth damage in 1986 indicate that populations will decline throughout those areas in 1987. The survey also indicated the western limit of the current gypsy moth area of distribution in Quebec; new egg masses were found near Shawville.

## Ontario

Gypsy moth populations were on the wane with moderate-to-severe defoliation declining from 246 342 ha in 1985 to 167 776 ha in 1986 (Figure 7). Most of the decline occurred in the older parts of the infestation in the Kaladar-Tweed area and consequently, moderate-to-severe defoliation in the Tweed District was reduced from 172 232 ha to 73 252 ha. A small decrease in the area of defoliation was recorded in adjacent areas of the Napanee District. In contrast, the outer periphery of the infestation continued to expand with substantial increases recorded in the Carleton Place and Brockville districts of the Eastern Region along with small increases in the Pembroke District of the Algonquin Region and the Lindsay District of the Central Region. Little change was recorded in the status of small, light infestations near Port Colborne in the Niagara District and Turkey Point in the Simcoe District.

The cooperative burlap larval trapping program, a joint project of FIDS and the Ontario Ministry of Natural Resources (OMNR) parks branch was again carried out at 64 provincial parks in southern Ontario. As expected, positive results were recorded at most

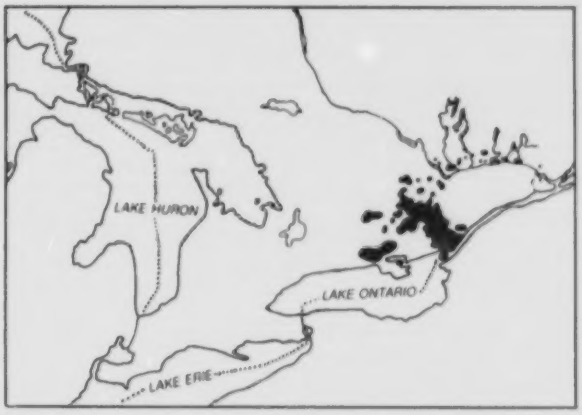


**Figure 7.** Areas of moderate-to-severe defoliation by the gypsy moth in eastern Ontario and western Quebec in 1986.

parks in the Eastern Region which is considered to be generally infested. More significant perhaps, were larval catches at the following parks outside the infested area indicating more widespread establishment of the insect: Bonnechere Provincial Park, Pembroke District; Petroglyphs Park, Bancroft District; Darlington, Emily, and Serpent Mounds Parks, Lindsay District; Bronte Creek Park, Cambridge District; and McCrea Point Park, Huronia District.

An adult pheromone trapping program was again carried out in southern Ontario parks in conjunction with the larval trapping program. This effort yielded positive catches of male moths at 63 of 64 locations in 1986 compared with catches at 51 of 67 locations in 1985. Perhaps more important was that increased numbers of moths were caught in many areas. This was particularly evident in the southwestern part of Algonquin Park as well as trapping sites in the Bracebridge, Parry Sound, Huronia, Chatham, Aylmer, and Wingham districts.

A similar trapping program which is carried out in northern Ontario parks and campgrounds also produced increased results. Catches were made at 15 locations this year compared with five locations in 1985. Most of the catches were made in the North Bay, Sudbury, and Espanola districts. Moths have now been captured for 2 consecutive years at one location and 3 consecutive years at another location on Manitoulin Island, Espanola District, indicating that low populations of the insect may have become established at these locations. In addition to the above, small numbers of male moths, usually one or two, were captured at Mississagi Wild River and Wakami Lake Parks, Chapleau District; Kap-kig-i-wan Park, Kirkland Lake District; and Mississagi Park, Blind River District. No moths were captured at Agawa Bay on Lake Superior where one adult was found in 1985, despite the deployment of extra traps this year.

The Ontario Ministry of Natural Resources launched its largest aerial spraying program to date against the gypsy moth in eastern Ontario. Helicopters and fixed-wing aircraft applied the bacterial insecticide *Bacillus thuringiensis* (B.t.) to 45 700 ha of Crown land and 57 400 ha of private land in the Tweed, Carleton Place, Brockville, and Napanee districts of the Eastern Region and the Pembroke District of the Algonquin Region. The operations, which began in mid-May and ended in late June, were generally successful in that foliage protection was achieved in many cases.

In 1986, for the second year, OMNR with some technical assistance from FIDS, carried out a large detailed egg survey, concentrating mainly on eastern Ontario. Preliminary analysis of the results shows that egg counts are down in many areas and consequently, further reductions in the area of defoliation can be expected in 1987.

## British Columbia

Nearly 7000 traps were placed throughout the province in the ninth successive year of a cooperative survey with Agriculture Canada (Plant Health) and more recently, the B.C. Forest Service. Following the discovery in 1985 of small numbers of egg masses and larvae at Canadian Forces Base (CFB) Chilliwack, small selected areas were sprayed with *Bacillus thuringiensis* in May 1986. In the fall of 1986, 24 adult male moths were caught in 19 traps at 8 locations in British Columbia including 8 at CFB Chilliwack, 3 at CFB Esquimalt at Belmont Park, 7 in the Kelowna area, 2 near Clinton, and single moths south of Kamloops, near Point Roberts, in Vancouver, and in Goldstream Provincial Park near Victoria. One moth trapped near Kelowna was in one of the 268 traps set as 233 forest recreation areas including national and provincial parks monitored by Forest Insect and Disease Survey. To date, egg mass searches by Agriculture Canada have been negative in Kelowna and Belmont Park while a small number of egg masses and female adults have been found at Chilliwack.

Despite periodic discoveries since 1978, populations have not yet become established nor has defoliation been observed. Although most hardwoods, shade trees, and possibly young conifers could be defoliated if populations become established, the major concern of the forestry sector would be potential quarantine restrictions and costly control requirements such as those implemented in active gypsy moth areas in Oregon. Intensive trapping programs and, if necessary, egg mass surveys will continue in 1987.

# Forest Tent Caterpillar

*Malacosoma disstria* Hbn.

The forest tent caterpillar again caused moderate to severe defoliation on trembling aspen, as well as a variety of other hosts in many areas of Canada (Figure 9). Although outbreaks of this insect can be spectacular in appearance, there have been few reports of appreciable tree mortality. The main effect of outbreaks has been the reduction in annual growth of severely defoliated trees. The significance of this reduction is difficult to assess. The affected tree species comprise a major portion of the hardwood volume in Canada, yet a relatively small portion of it is harvested each year. As the utilization and management of aspen intensify, the impact of aspen defoliators will become more significant.

## Newfoundland

Pheromone traps were monitored throughout the Island near parks and major towns to collect any moths that might be introduced on vacation vehicles. Only male moths have been caught in these traps.

## Maritime Provinces

The forest tent caterpillar, the major defoliator of hardwoods in the Maritimes since the late 1970s, has been on the decline in the past few years, and except for a very small area in eastern Nova Scotia, is considered to have ceased to be a major forest pest for the present (Figure 8).

The outbreak ended in New Brunswick and Prince Edward Island in 1985 and the area of moderate or severe defoliation was drastically reduced in Nova Scotia (Table 4).

Table 4. Forest tent caterpillar outbreaks in the Maritimes Region (1978–1986)

| | Areas of severe/moderate defoliation (ha) | | |
|---|---|---|---|
| Year | N.B. | N.S. | P.E.I. |
| 1978 | few small patches | — | 5 000 |
| 1979 | 37 000 | — | 5 000 |
| 1980 | 177 000 | trace | 3 100 |
| 1981 | 775 000 | small patches | 13 800 |
| 1982 | 1 389 000 | 4 700 | 18 800 |
| 1983 | 1 119 000 | 35 000 | 67 000 |
| 1984 | 94 400 | 46 400 | 37 400 |
| 1985 | — | patches | — |
| 1986 | — | patches | — |

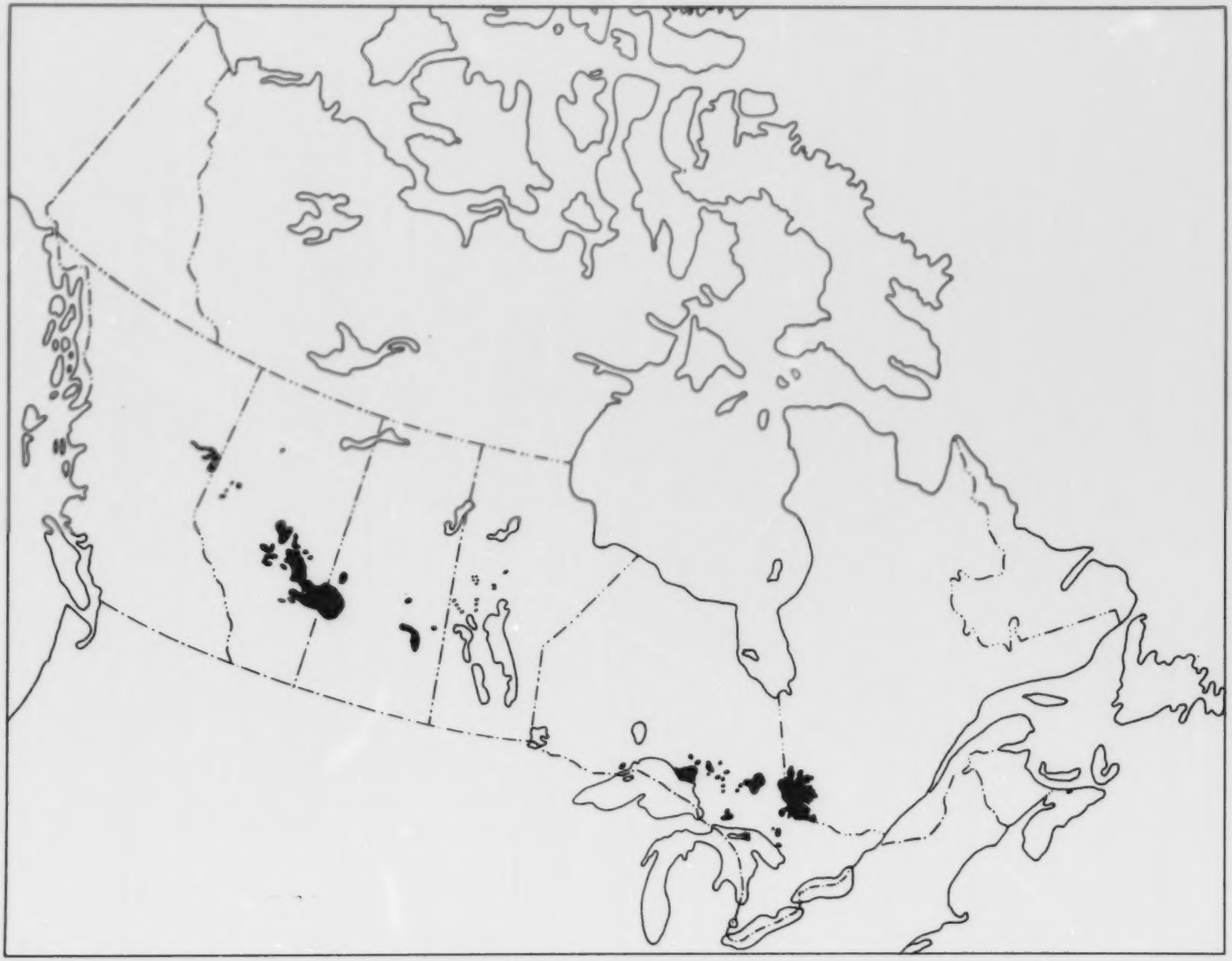

**Figure 8.** Areas of moderate-to-severe defoliation by the forest tent caterpillar.

The insect feeds on a wide variety of hardwood trees with preference for trembling aspen, oak, apple, birch, and cherry. When populations are high and larvae migrate in search of food, other tree species such as sugar maple, ash, alder, elm, and ground vegetation are also readily defoliated. Feeding also occurs on some conifers, notably larch and white spruce.

In New Brunswick, no noticeable defoliation occurred in 1985 for the first time since 1978 — a total collapse — and none was observed in 1986. The outbreak began in 1978 near Woodstock, Carleton County and by 1982 covered much of the southern half of New Brunswick. In 1984, a dramatic reduction in insect population occurred. Factors which contributed to this collapse included a build-up of disease, parasites, predators such as the *Sarcophaga* flesh fly, mass starvation of larvae, and unfavorable spring weather conditions.

In Nova Scotia, forest tent caterpillar, in combination with the large aspen tortrix (*Choristoneura conflictana*), caused severe defoliation over about 200 ha near Granton, Pictou County, on the eastern Mainland. The outbreak in western Nova Scotia, which caused moderate and severe defoliation in patches in Hants, Kings, and Annapolis counties in 1985, collapsed and no defoliation occurred there or anywhere else in the province in 1986.

In Prince Edward Island, the outbreak which had persisted in Prince County since 1973 collapsed in 1985 and no defoliation occurred in 1986.

Fall egg mass surveys, the results of the pheromone trapping program, and light trap catches all indicate the forest tent caterpillar populations will be practically nonexistent in 1987, and no defoliation by this insect is expected anywhere in the region.

## Quebec

The rise in forest tent caterpillar populations in the Abitibi-Témiscamingue région continued for the third consecutive year. From several pockets of infestation first observed in the Témiscamingue area in 1984, the infestation by this insect has expanded to include in 1986 a vast area situated primarily between the municipalities of Rouyn and Temiscaming. The infestation recorded in 1986 was larger everywhere than that of 1985 and increased in area by 0.3 million ha. The total infested area in 1986 was 0.57 million ha, of which 0.39 million ha suffered severe defoliation.

Serious damage (moderate to severe) was observed along highways 101, 391, and 382 and throughout the area bounded by the Ontario border to the west, Montbeillard to the north, lakes Simard and Saseginaga to the east, and the town of Temiscaming to the south. Most of the municipalities in the Témiscamingue area thus were strongly affected by the insect. Pockets of light defoliation were also observed along the fringe of the severely infested zone. The forest tent caterpillar was also found more frequently in 1986 in the western part of the Outaouais region, although its presence there was sporadic and no notable defoliation was observed.

To determine the importance of the principal natural control factors in forest tent caterpillar epidemic populations, 1223 insects in the immature stages were collected from May 28 to July 3 in five severely defoliated forest sectors of the Témiscamingue area. Laboratory breeding of the insects in the larval stage yielded a mortality rate of 40%, 36% of which was attributable to a natural viral disease. Among the 489 chrysalids collected for laboratory breeding, more than 74% were eliminated by natural factors, including 61% by the dipter, *Sarcophaga aldrichi* Park. This forest tent caterpillar parasite, and the viral disease, will help dampen the current infestation. An egg mass survey conducted in 47 observation sites indicates that again there will be a strong forest tent caterpillar presence in the spring of 1987 in those areas where defoliation was moderate to severe in 1986. The studies of natural control factors, however, suggest a significant reduction in insect population levels is likely, primarily where the infestation has been most spectacular in the last two years.

## Ontario

The forest tent caterpillar caused 433 000 ha of moderate-to-severe defoliation in the province in 1986, up from 208 942 ha in 1985. Infestations increased in the Northeastern, Northern, and Algonquin regions and declined in the North Central Region.

In the North Central Region, the old infestation south of the city of Thunder Bay, declined from about 5 000 ha in Crooks Township in 1985 to about 520 ha this year. Egg-band counts indicate populations in this area will be generally low but a few very small patches of defoliation may persist.

In the Northeastern Region, the largest infestation in the province encompassed about 245 090 ha along the Quebec border in the eastern North Bay and Temagami districts. The same infestation extended north into the Kirkland Lake District of the Northern Region, affecting an additional 87 550 ha in that district. The remainder of the infestations in the Northeastern Region consists of about 50 widely scattered pockets ranging in size from about 40 ha to 8 750 ha in the North Bay, Espanola, and Wawa districts. The largest and most important of these (8 750 ha) was located in a large sugar maple stand on Michipicoten Island in Lake Superior. Most of these pockets were inaccessible and, therefore, no egg-mass counts were made, but counts in six pockets which were accessible, indicate that heavy defoliation can be expected in most areas in 1987.

Egg-band counts in the large infestation described above indicate that defoliation will persist at high levels and considerable expansion to the south and east may occur.

In the Northern Region, the largest area affected (87 550 ha) was in the southeast corner of the Kirkland Lake District described earlier. In addition, a second infestation of about 51 555 ha straddled the Kirkland Lake–Gogama district boundary. An additional 45 pockets ranging in size from 50 to 1 770 ha were scattered throughout the Chapleau and Gogama districts. As in the Northeastern Region, many of the pockets were inaccessible but egg counts in the two larger infestations and a few of the smaller ones indicate that heavy defoliation will recur in 1987. The only exception is in the southeast Kirkland Lake District where some lessening of defoliation may occur in the older parts of the infestation. In the Parry Sound District of the Central Region about 11 160 ha of moderate-to-severe defoliation occurred in 11 discrete pockets in the northern, central and southern portions of the district. Egg counts here indicate that continued heavy defoliation will occur in the next year with some possible expansion into adjacent areas of the Bracebridge and Huronia districts. Egg counts and past experience indicate the potential exists for heavy defoliation and considerable expansion of the forest tent caterpillar infestations in the northeastern part of the province along with smaller but significant increases in the southern part of Ontario.

### Prairie Provinces

In Manitoba, a few small scattered areas of moderate-to-severe defoliation patches of aspen were mapped, caused mostly by the forest tent caterpillar. Most occurred in the west-central part of the province.

In Saskatchewan and Alberta, the forest tent caterpillar caused widespread defolation in much the same areas as in 1985. The main infestation areas extend across the central part of Alberta and into west-central Saskatchewan. Additional areas are located in the Grande Prairie area and in east-central Saskatchewan. Total area of infestation in the two provinces is estimated to extend over 1 000 000 ha (est. 398 000 ha in Saskatchewan).

Egg-band surveys indicate that high populations are expected within the same areas in Alberta and Saskatchewan, and may even expand beyond that reported this year.

An area of recent and current forest tent caterpillar defoliations, extending throughout an area within the agricultural zone of about 17 000 km$^2$ in east-central Alberta and west-central Saskatchewan had variable amounts of aspen mortality and top-kill. This is believed to have resulted from a combination of weakening by forest tent caterpillar defoliations, summer drought conditions during 1983 and 1984, and early and late spring frosts in 1986 prior to and at the time of budbreak.

Resource use of aspen is rapidly expanding in the prairie provinces and this may require a greater focus on monitoring and management for insect and disease organisms. In Alberta, extensive cull surveys are being planned in areas slated for expanded aspen utilization. Presently two of the most common disease fungi contributing to aspen decline and decay are *Hypoxylon mammatum and Phellinus igniarius.*

### British Columbia

About 93 500 ha of trembling aspen, some black cottonwood and other deciduous trees were defoliated by forest tent caterpillar in northern British Columbia and, to a lesser extent, in the western part of the Nelson Region. For the fourth year moderate and severe defoliation occurred from Tupper to Fort St. John in the Peace River area and there was a major expansion along the Pine River. Only patches of aspen in the Salmon River Valley north of Prince George were defoliated following a population decline in 1985. Infestations expanded tenfold in the Nelson Region and severely defoliated 37 areas totalling 1 200 ha, some for the third year near Trail and Castlegar and east of Creston. Populations collapsed between Kitwanga and Moricetown in the Prince Rupert Region after 3 years of infestation. Reduced egg hatch from smaller and less healthy egg masses contributed to the collapse.

Egg surveys in the Peace River area and the Nelson Region indicate moderate or severe defoliation can be expected in 1987.

## Hemlock looper

*Lambdina fiscellaria fiscellaria* (Gn.)

The hemlock looper is native to Canada and occurs from Newfoundland to Alberta, mainly on balsam fir. During an outbreak, however, it will feed on many conifers and even some hardwoods. Although all eastern provinces have periodic outbreaks, Newfoundland has regular epidemics lasting from 3 to 6 years and occurring every 10–15 years.

### Newfoundland

***Defoliation*** — The larval and aerial defoliation surveys showed that moderate and severe defoliation occurred on about 215 000 ha. Severe reddening of balsam fir foliage was evident in the Codroy Valley from Brooms Brook to Codroy Pond, in the headwater areas of the major rivers of southwestern

Newfoundland, from the Port au Port Peninsula to Corner Brook including the Cooks Brook area, from Cormacks Lake to Red Indian Lake, and in isolated areas from Hughes Brook to Bonne Bay Pond and from Rocky Harbour to Western Blue Pond in western Newfoundland. Severe defoliation also occurred near Gander in Terra Nova National Park, near Triton Brook and Lake St. John, and on parts of the Bonavista and Avalon Peninsulas (Figure 9). Light defoliation was recorded on about 117 000 ha in 1986, extending from Bay of Islands to Lomond and from Bellburns to Hawkes Bay and near Ten Mile Lake in western Newfoundland. Light defoliation also occurred in numerous, isolated areas from Gander Bay to Random Island and in a few areas on the Bonavista and Avalon Peninsulas. Looper larval numbers were too low to cause noticeable defoliation in many stands forecast for light defoliation in 1986. However, these areas are of prime concern because of the possible expansion of the outbreak in 1987.

***Control*** — The Department of Forest Resources and Lands conducted an operational control program against the hemlock looper, treating about 81 000 ha with fenitrothion and about 5 000 ha with *Bacillus thuringiensis* (B.t.).

The Canadian Forestry Service in cooperation with the Department of Forest Resources and Lands conducted an experimental program testing the effectiveness of new formulations and dosages of fenitrothion and Dimilin®.

In 1986, samples of hemlock looper larvae and pupae were collected from several areas. About 0.4% of the looper samples were parasitized. The common larval parasite was an ichneumonid species and the pupae were parasitized by a tachinid species. Fungal pathogens caused an average of about 4.5% mortality of the reared larval samples. However, larval mortality from pathogens reached as high as 20% in the oldest part of the outbreak on the Avalon Peninsula as compared to only 2% in samples from western Newfoundland. The principal fungal pathogen was *Entomophaga aulicae*. Other fungal pathogens detected were *Paecilomyces farinosus* and *Verticillium lecanii*. Both *P. farinosus* and *V. lecanii* are new host records. About 0.5% of larval samples were infected by an undescribed microsporidian.

**Figure 9.** Areas of moderate-to-severe defoliation by the hemlock looper in Newfoundland in 1986.

***Damage*** — Most of the severe defoliation occurred in western Newfoundland in predominantly mature and overmature stands, but some semimature stands were also severely damaged. Tree mortality may reach 80% in some stands within the next 2 years. In eastern Newfoundland, more stands with new mortality were observed in the Terra Nova National Park, Triton Brook, Lake St. John, Ocean Pond, Long Harbour, Windsor Lake, and near Aquaforte. The Department of Forest Resources and Lands will assess the damage at the inventory level.

***Forecast*** — The egg survey commenced in mid-October and branches were collected from about 830 sample points throughout the Island. Based on the comprehensive analysis of all data available about the outbreak, including results of the egg survey, and assuming favorable weather during larval development, the total area of moderate and severe defoliation forecast for 1987 is about 327 000 ha distributed mostly in western Newfoundland. Light defoliation is forecast to occur on about 90 000 ha. Very low egg density (less than one egg per branch sample) was present in an additional 42 000 ha but defoliation may not become noticeable in these areas. The areas of moderate and severe defoliation are expected to further decrease in central and eastern Newfoundland as indicated by the relatively high incidence of disease in these older infestations. However, severe defoliation is expected to continue and expand in western Newfoundland.

## Maritime Provinces

Hemlock Looper, contrary to its name, is mainly a defoliator of balsam fir in the Maritimes. It is capable of causing serious damage when populations are high. It feeds on needles of all age classes and is a wasteful eater. Larvae chew off but do not consume all of the needles, consequently a much greater amount of foliage is removed than necessary for their development.

In the Maritimes, populations have been generally low in the past few years. The last serious outbreak occurred in central Prince Edward Island in 1977 and 1978 when the insect killed 80% of the merchantable

balsam fir and over 90% of the hemlock in the affected area.

In 1986, the hemlock looper population, reported in 1985, persisted in the area of Diligent River, Cumberland County, Nova Scotia. Many balsam fir trees are in poor condition in the area but this is partly due to the presence of the spruce budworm. The Nova Scotia Department of Lands and Forests carried out an aerial control program with the biological insecticide B.t. (Dipel® 132R), applied (at 30 BIU/ha) over 136 ha in this infested forest. A major moth flight was reported late in the season in the Diligent River – Fox River area of Cumberland County which suggests that the infestation may persist into 1987. Populations of the insect were low in the rest of the province.

In Prince Edward Island, the infestation collapsed near Cross River, Kings County, where patchy, but in some places severe, defoliation was reported in 1985. The insect was present in a few other areas but generally at low populations. Light defoliation occurred on a few balsam fir trees at Devon, Kings County.

In New Brunswick, hemlock looper populations remained generally low. The highest populations were observed in the Alma area of Albert County but even there no noticeable defoliation occurred.

## Dutch elm disease

*Ceratocystis ulmi* (Buis.) C. Moreau

Dutch elm disease is caused by the fungus *Ceratocystis ulmi*, which is transmitted chiefly by elm bark beetles. It was accidentally introduced into Canada and since its first discovery in Quebec has spread over an area stretching from southern Manitoba to the Atlantic Ocean, excluding Newfoundland. All native species of elm are susceptible, including white, red, and rock elms. The disease has caused extensive mortality in eastern North America and will probably become a serious problem in all areas where elms are grown. Few, if any, pests have had as great an impact on shade tree populations in urban areas as has Dutch elm disease. Elms are also valuable timber-producing species in some areas and there the disease has had an important effect on the local economy.

### Maritime Provinces

Dutch Elm Disease as a major concern in all three Maritime provinces in 1986.

In New Brunswick, the disease is present wherever elm trees are found. The resurgence of infection, reported in 1984, continued. Numerous infected and dying trees, both residual old trees and young saplings, were observed throughout the province in 1986, although the intensification on younger trees appeared somewhat reduced from levels observed in 1985. The disease was found in two new areas forthe first time in 1986. The infection in eastern Northumberland County represented only a minor extension in distribution; the other find, that on Deer Island, Charlotte County, represents the intrusion of the disease into a hitherto unaffected area of the province.

In Nova Scotia, the range of the known distribution of the disease was extended considerably on Cape Breton Island as the disease was found for the first time in a number of areas in 1986, including the first diseased elm tree identified from Victoria County. There was a minor extension in range on the mainland as the disease is spreading into the still unaffected areas of Antigonish County. The intensification of the disease, evidenced by great numbers of dead and dying elm trees, continued within outbreak areas where no sanitation is practiced. A multigovernmental, multiagency, control program aimed at Dutch elm disease control in Nova Scotia resulted in more than 550 samples for identification by the Forest Insect and Disease Survey in 1986. Less than two-thirds of the samples were found to have the disease.

On the permanent assessment plot near Newport, Hants County, where 11% of the trees became infected between 1980 and 1982, the infection rate increased to 55% in 1983, to 69% in 1984, to 74% in 1985, and to 76% in 1986. The pattern agrees closely with that found in other areas of the Maritimes, although intensification here is somewhat slower, probably because some infected trees have been removed.

In Prince Edward Island, two infected trees were found in 1986 at Tyne Valley, Prince County, near the area where the disease was first discovered in 1979. The initial discovery was followed by an immediate and vigorous sanitation cut by the provincial government. No infected trees were found in 1980 and 1981, one infected tree was identified and removed in 1982, there were none found in 1983 and 1984 and one tree was found in 1985. There appears to be a source of infection in the general area of northcentral Prince County. Although at present the incidence of infection is low, scrupulous surveillance, increased public awareness, and removal of beetle-breeding material in communities where elm is of value as a shade tree are advised.

In Fredericton the progress of Dutch elm disease and the effects of the control program have been monitored since 1961 when the disease was first found in the city. The 25 trees killed by the disease in 1986 represented 0.8% of the current elm population within the Dutch Elm Disease Management Area. This loss is well in line with the reduction in the loss rate since 1980 when it peaked at 7.8% followed by 5.3% in 1981, 3.0% in 1982, 2.4% in 1983, 1.1% in 1984, and 1.2% in 1985. The 0.8% annual loss in 1986 is the

lowest since 1974, the last year when the loss rate was below 1% of the current elm tree population. Losses to date amount to 28.2% of the original urban elm stand.

No systematic survey was conducted by the Forest Insect and Disease Survey in 1986 for elm bark beetles, the carriers of Dutch elm disease, except in Fredericton, where populations of the native elm bark beetle, *Hylurgopinus rufipes* (Eichh.) remained low. One adult of the smaller European elm bark beetle, *Scolytus multistriatus* (Marsh.), was captured on a sticky monitoring trap. This insect, the more important vector in spreading Dutch elm disease in the United States and recently increasing in numbers in southern Ontario, has not been a factor to date in Fredericton. Single adults were captured in pheromone traps in 1982 just south of the city and in 1983 at Tay Creek, about 30 km to the north.

### Quebec

Mortality of white elms caused by Dutch elm disease reached 100% in some stands near the Kinojevis River, southwest of Saint Joseph of Clericy (Abitibi-Témiscamingue). The disease was also observed for the first time along the Ticouapé River, 9 km north of St. Method (Saguenay-Lake Saint Jean). The disease has spread along the Noire River, 7 km south of Lake Deschênes (Charlevoix) and has caused mortality of a few elms.

### Ontario

Dutch elm disease was observed at significant rates of infection in ornamentals and hedgerow trees in the Thunder Bay, Cornwall, and Pembrooke districts.

### Manitoba

In Manitoba, Dutch elm disease surveys were conducted primarily by the Manitoba Department of Natural Resources.

During the 1986 summer surveillance season, approximately 13 000 elms were examined in and around urban and rural municipalities. Of these, 2 948 were confirmed to have Dutch elm disease and 9 879 were classified as hazards, many of these probably dead as a result of the disease. Because of the large number of elms infected in wild stands throughout southern Manitoba, particularly in eastern and central regions, control efforts were again concentrated on elms in and around cost-sharing communities. Trees in the wild were largely ignored because of impracticality of controlling the disease in those areas.

The number of municipalities reporting Dutch elm disease increased from 72 to 77 this year. Included are major urban centres like Winnipeg, Brandon, Portage la Prairie, Carman, and Selkirk as well as major parks such as the North West Angle Provincial Forest, Spruce Woods, and Whiteshell Provincial Parks, and the Riding Mountain National Park.

Although Dutch elm disease continues to increase in the wild stands, diseased elms in urban centres with control programs were comparably low. Less than 1% of Winnipeg's elms were diseased, and in Brandon, less than 2% of the elms were infected. Most of these trees are found in the wild stands along the river banks where control measures are less effective. The City of Winnipeg reported 3 218 samples taken this year of which 2 219 were confirmed as diseased and an additional 5 464 were marked as hazards.

The disease has continued to increase among elms along most of southern Manitoba's rivers. Large increases in diseased trees have occurred on the Red and Assiniboine rivers around Winnipeg, along the Assiniboine to Portage la Prairie and Brandon, and west of Brandon as far as the St. Lazare area. The Whitemud River around Westbourne has shown a considerable increase in diseased trees, as well as the east escarpment of Riding Mountain National Park. The smaller river and creek systems in south central Manitoba also experienced more pockets of infection, thus endangering the farm shelterbelts in the areas around Winkler, Altona, Morden, and Carman. The Souris River southwest of Brandon was surveyed by air and elms were reported to be extensively infected right into the United States and back into Saskatchewan. However, the natural elm population drops off just a few kilometres into Saskatchewan.

### Saskatchewan and Alberta

In Saskatchewan intensive aerial and ground surveys did not detect any diseased trees in 1986. Endemic populations of the native elm bark beetles were found in native elm areas in the province.

No evidence of the native elm bark beetle or Dutch elm disease was found in Alberta.

## Scleroderris canker

*Ascocalyx abietina* (Lagerb.) Schläpfer-Bernhard (*Gremmeniella abietina* (Lagerb.) Morelet)

Scleroderris canker has been detected in all provinces except Prince Edward Island, Manitoba, and Saskatchewan. This disease of conifers is caused by the fungus *Ascocalyx abietina*. At least two races of this fungus (North American and European) have been determined serologically.

### North American Race

The North American race of *A. abietina* is widely

distributed in Canada and has been a serious problem in nurseries and young plantations for many years. Extensive studies of the disease have provided several control recommendations. In Eastern Canada the disease is most damaging to pines, especially red, jack, and Scots pines, and often kills them during their first decade of growth. Once the trees are about 2 m high, they are relatively safe from lethal attack. In Western Canada, where lodgepole, ponderosa, and whitebark pines are the principal hosts, the disease has occurred at only a few scattered locations in Alberta and British Columbia. No significant damage has been attributed to this disease in either province.

## Maritime Provinces

Scleroderris canker was first found in the Maritimes Region in 1971. The disease is widespread in New Brunswick, especially in the northern half of the province and infects mostly plantations of jack, red, and Scots pine. In Nova Scotia, where the disease was first found in 1972, a few plantations of red, jack, and Scots pine suffered limited lower branch mortality during the mid-1970s. The disease was last found in Nova Scotia in 1978, and appears to have died out. It has never been found in Prince Edward Island.

In 1986, the disease was found only at one location in New Brunswick, in a red pine plantation near Deersdale, York County, where lower branch infection occurred.

## Quebec

Scleroderris canker was found in the Duchesnay, Normandin, Saint Luce, Saint Modeste and Trécesson nurseries. In the latter, two jack pine lots and one red pine lot were contaminated with the disease, and six windbreaks had nearly 25% of jack pine stems affected. In the Saint Modeste and Normandin nurseries, a low percentage of red pine (3%) were affected. In Saint Luce, Duchesnay, and Saint Modeste, the disease was found in Scots pine, red pine and Austrian black pine windbreaks.

Scleroderris canker was found in container-grown jack pine in one nursery in the Saguenay/Lake Saint Jean Region. Stringent sorting was recommended to eliminate affected seedlings (1% of 1 million) and spraying was conducted to protect other seedlings against new infestation. This pathogen was also found on a small exotic pine lot in the Montreal Region.

## Ontario

Surveys for the North American race indicated that infections were at a generally low ebb in 1986. The highest infection rate was recorded in a known infection centre in Houghton Township, Blind River District, where 42% infection and 5.3% mortality were recorded in a mixed red and jack pine plantation. A small plantation of 1-m red pine in adjacent Kirkwood Township had 20% infection and 0.6% mortality, and a 10-ha jack pine plantation in Gaudette Township, Sault Ste. Marie District, had 18% infection and 4% mortality. A recheck of a previously known infection centre in the Ozhuskans Rapids area of Red Lake District indicated that 6% of the 1-m jack pine were infected. A single new infection centre was discovered in Timbrell Township, Sault Ste. Marie District, where 3% of the 1-m trees in a 25-ha red pine plantation were infected. Reports of the disease, usually at very low infection levels, were also received from the Wawa, Kenora, Fort Frances, Dryden, North Bay, and Chapleau districts.

## European Race

In 1975 a disease syndrome different and more serious than that normally associated with scleroderris canker in North America was reported in New York State. The disease was killing large pine trees and was serologically identified as the European race of *A. abietina*. It has since been detected at scattered locations in Newfoundland, New Brunswick, Quebec, and Ontario (see Figure 10 for Ontario). Except in Newfoundland, the symptoms and damage caused by the European race have been indistinguishable from those of the North American race.

**Figure 10.** Positive sample points of the European race of scleroderris canker of pine found in eastern Ontario.

## Newfoundland

A branch sample taken in late 1985 from a Sitka spruce grown in an experimental plantation near Roddickton was confirmed in early 1986 to be damaged by Scleroderris canker. This is the first record of the disease outside the Avalon Peninsula. In 1969 and 1970, eight other plantations were estab-

lished throughout the Island using the same stock of seedlings imported from New Brunswick. In addition, some seedlings were provided to the province and industry for use in their planting program. The examination of these plantations in 1986 showed various amounts of old mortality, recent branch dieback, and top-kill. The development of these symptoms appeared to be very gradual, taking place over several years. Branch samples were taken from these plantations for cultural identification of the disease and subsequent determination of its race. Cultures obtained from the Sitka spruce plantation near Roddickton and all other previous Scleroderris isolates in Newfoundland were diagnosed as the European race. Culturing of samples from the other eight Sitka spruce plantations are in progress. Following the results of the culturing, the damaged trees will be pruned or cut and burnt in an effort to control the disease.

Scleroderris canker also affected 30% of Austrian pine trees on Pitts Memorial Drive near St. John's. The trees were pruned to control the spread of infection.

## Maritime Provinces

The European and several other "intermediate" races have been found in New Brunswick at 11 locations since 1978. Eradication attempts at a forest nursery, in a Christmas tree plantation, and in a commercial plantation appear to have been successful in eliminating the disease. The remaining eight plantations have been under close annual surveillance for changes in symptom expression, which at the current stage of disease development are indistinguishable from those of the North American race. In addition, samples from each area are serologically analyzed for race determination. The fact that none of the samples since 1983 proved to be of the European race gives rise to cautious optimism regarding the future of this race in the Maritimes.

## Quebec

In 1985, the provincial Insect and Disease Protection Service conducted an extensive survey to determine the presence of the European race of scleroderris canker in southwestern Quebec red pine and Scots pine plantations. Among the 133 plantations found to be infected with scleroderris canker (8% of plantations visited), 87 were studied in isolate form to determine the race of the fungus. Results indicated that 57% of these pure cultures were of the European race. Table 5 shows that red pine plantations were primarily affected by this race. Following on the results of this project, 12 plantations in the Outaouais region infested by the European race of scleroderris canker were included in a pruning program in 1986. More than 120 trees spread over 50 hectares were treated.

This extensive survey project continued in 1986. The portion of the Montreal Region situated east of the Richelieu River, as well as the Lower Saint Maurice management unit of the Trois Rivières Region constituted the areas of investigation. Scleroderris canker was located in 13.5% of the 933 plantations visited. Table 6 shows the distribution of plantations visited by management unit, as well as the number of infested plantations. The Laurentian Forestry Centre is responsible for determining the race of the fungus; however, results are not yet available.

Also in 1986, 8.5% of plantations visited were subject to quantitative assessment to determine the amount of scleroderris canker in the areas visited. Plantations to be assessed were selected systematically. Results indicate that 60 of 79 assessed sites had no infested trees, while 16 plantations contained less than 2% infested trees. Two plantations had 2 to 5% of their trees infested, while one plantation had 6 to 25%. A tree is considered infested when the presence of a canker is noted on the trunk or when at least 25% of its branches have signs or

Table 5. Results of *Ascocalyx abietina* race identification under the special survey conducted in 1985 in southwestern Quebec regions, expressed in number of plantations

| Administrative region | Species | *Ascocalyx abietina* race | | |
|---|---|---|---|---|
| | | American | European | Total |
| Eastern Townships | Scots pine | — | 4 | 4 |
| Montreal | Red pine | 28 | 31 | 59 |
| | Scots pine | 6 | 3 | 9 |
| Outaouais | Red pine | 3 | 11 | 14 |
| | Scots pine | — | 1 | 1 |
| Total | | 37 | 50 | 87 |

Table 6. Results of plantation visits under the scleroderris canker survey.

| Areas Visited | Plantations Infested | | Healthy | | Total |
|---|---|---|---|---|---|
| Trois Rivières administrative region: | | | | | |
| Lower Saint Maurice, north shore | 101 | (34.0)* | 199 | (66.0) | 300 |
| Lower Saint Maurice, south shore | 23 | ( 4.8) | 457 | (95.2) | 480 |
| Montreal administrative region: | | | | | |
| South of Montreal | 2 | ( 1.3) | 151 | (98.7) | 153 |
| Total | 126 | (13.5) | 807 | (86.5) | 933 |

*( ) expressed in percentage

symptoms of the disease. A progress report on this project will be released in spring 1987.

### Ontario

The European race of this disease was first found in 1985 when the pathogen was identified from three locations in the Algonquin Region. Single red pine plantations were infected in Macauley Township, Bracebridge District, and McMurrich Township, Parry Sound District, along with two red pine plantations in Mayo Township, Bancroft District. Remedial action in the form of clear cutting and burning or high pruning was carried out at all three locations.

In 1986, an intensive program of aerial and ground surveys were carried out around the area of the initial finds. From this program two new infection centres were identified in Mayo Township adjacent to the original find and one new infection centre in the south part of McMurrich Township. Recently, three collections made late in the 1986 field season from a plantation about 1 km north of the McMurrich Township location were confirmed as the European race. Further intensive surveys will be carried out in these highly suspect areas in 1987 along with the regular detection survey which is carried out in the remainder of southern Ontario.

## European larch canker

*Lachnellula willkommii* (Hartig) Dennis

### Maritime Provinces

European Larch Canker, caused by the fungus *Lachnellula willkommi* (Hartig) Dennis, was first discovered in the Maritimes in 1980. Subsequent surveys established the distribution of the disease as widespread in southeastern New Brunswick and on mainland Nova Scotia. European larch canker has been a serious disease in many parts of Europe. The fungus is considered, by most, to be a primary pathogen (capable of infecting vigorous, healthy trees) and its presence has resulted in the exclusion of larch from plantation programs in parts of Europe. In North America, the fungus was first found in Massachusetts in the 1920s in European larch plantations. Periodic concentrated eradication attempts apparently were successful as the disease was not found during surveys of the area in 1965. However, it was discovered in northeastern Maine in 1981.

The fungus infects mostly young trees; therefore, future wood supplies may be affected. Tree mortality reduces stocking, branch mortality reduces growth, and cankers reduce wood quality. The extent to which the disease will cause damage in the Maritimes is not yet known but the potential for damage is there, and the role of the disease will have to be considered in view of increased emphasis on forest renewal and larch tree improvement programs.

In 1986, the disease was found only at one location outside the range of the known distribution, west of Torbay, Guysborough County, Nova Scotia, where one tree was found affected. More than 75 other areas surveyed in unaffected areas of the three provinces in 1986 were negative (Figure 11).

Investigation of several aspects of the behavior of the fungus under the climatic conditions in the Maritimes has been initiated. Results will be reported as they become available. A survey to establish age and spread pattern indicates that the fungus could have been present in the Maritimes for about two decades before its discovery and may have spread from

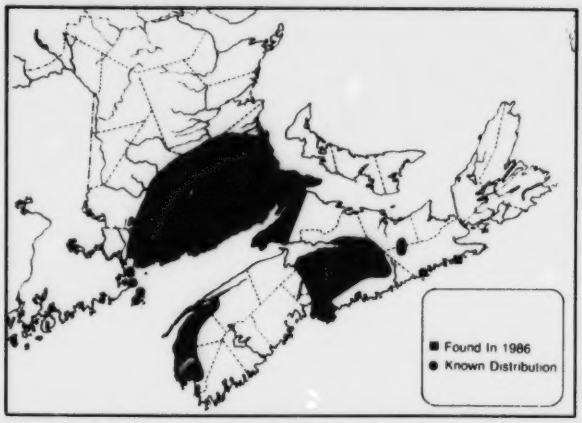


**Figure 11.** Known distribution of European larch canker in the Maritime Provinces.

specific areas. The study also showed a rapid decrease in incidence of infected trees with increasing distance from the Bay of Fundy, possibly indicating a climatic dependence.

The disease is capable of intensifying rapidly in young stands. Incidence of infected trees in a research plot increased as follows, based on fall assessments: 1982 — 7%; 1983 — 19%; 1984 — 46%; 1985 — 88%, and 1986 — 91%.

Greenhouse-grown seedlings of 22 populations of *Larix decidua*, *L. leptolepis*, *L. eurolepis*, *L. laricina*, and *L. sibirica* were successfully planted in a heavily infected area in the early summer of 1983 to test differences in susceptibility to infection. *Larix occidentalis* seedlings were added to the test in 1985. Cankers, bearing fruiting bodies of *Lachnellula willkommii*, were found on three *L. decidua* seedlings in the fall of 1984. By the fall of 1985, 11 of the 24 living larch populations had at least one seedling infected by the disease. The species affected were *L. dedicua*, *L. leptolepis* and native tamarack, *L. laricina*. No new larch populations became infected in 1986, however, additional seedlings of already affected populations did show signs of disease.

## Decline and dieback and stress-related disorders

### Maple Dieback and Decline

Much has been said and written in recent years about the sugar maple decline affecting vast areas of eastern North America, especially Quebec, and on its effects on the maple sugar industry and other forestry-related activities. For example, an aerial survey in southeastern Quebec in 1985, involving about 2.5 million ha of forest area, of which over 530 000 ha was of maple forest type, showed that about 40% of the maple stand area fell into dieback classes above 10%. Stem mortality was also recorded in 61% of the maple stands affected by dieback. In southern Ontario, a survey of 34 sugar maple stands in 1984 found 22.7% of the trees exhibiting some level of dieback, with 6% of the total in the severe category. Opinions on the cause of the deteriorating condition of sugar maple vary greatly, from weather patterns, through mineral deficiencies or changes in soils, forest pest conditions, air pollution, ozone damage, and forest management practices to acid rain.

### Maritime Provinces

Regardless of the cause, these problems exist and concern over the extension of the decline into sugar maple in the Maritimes has been expressed. Early in 1986, a committee composed on the Canadian Forestry Service, the Extension Service of the New Brunswick Department of Natural Resources and Energy, and the New Brunswick Department of Municipal Affairs and Environment, was established. A program was initiated to determine the status of sugar maple in New Brunswick with special emphasis on commercial operations. Following a mail survey, involving questionnaires to about 300 producers, the Forest Insect and Disease Survey conducted an assessment in the stands owned by the 42 respondents and in a few additional natural, unmanaged maple stands, as a first step before proceeding with more detailed surveys.

In each of the 48 stands examined, 50 maple trees were classified according to the following variables: species, diameter at breast height (DBH), tree class, dieback class, the presence or absence of sugar maple borer, and the number and condition of tap holes. A severity index was calculated for each stand by multiplying the number of trees in a given class with the assigned factor and adding these for the stand (Severity index = [$\Sigma$ (Class factor) (No. of trees in class)]). Thus, a stand with 50 healthy trees has a severity index of 50 and a higher severity index indicates a stand in progressively worse condition.

The standard hardwood dieback classification was used and the arbitrarily assigned "severity factors" were as follows:

| Dieback class | Severity factor |
|---|---|
| Healthy | 1 |
| Healthy but stressed | 1.5 |
| Twig dieback only | 2 |
| Branch dieback: 1–25% | 3 |
| Branch dieback: 26–50% | 4 |
| Branch dieback: 51%+ | 5 |
| "Barely alive," adventitious branches only | 6 |
| Dead — recent — green cambium at DBH, no foliage | 7 |
| Dead — twigs still present | 8 |

Of 2400 trees assessed, 2073 were sugar maple and 327 red maple. Figure 12 shows the distribution and severity index for the stands surveyed. (The index was appropriately adjusted for sugar maple when red maple was also present in the stand). The healthiest stands were found in northwestern New Brunswick, the poor stands were distributed throughout. Although less than one-quarter (22.5%) of the sugar maple trees in the province were classified as healthy in terms of dieback, another 71.4% of the trees had less than 25% crown dieback (Table 7). Most trees in the 1–25% dieback category had only one or two branches affected, often associated with sugar maple borer or other disorders, and were at the "better end" of this category. Only 6.1% of the sugar maple trees were in poor condition, with more than 25% of their crown affected. In comparison, the condition of red maple was worse than that of sugar maple.

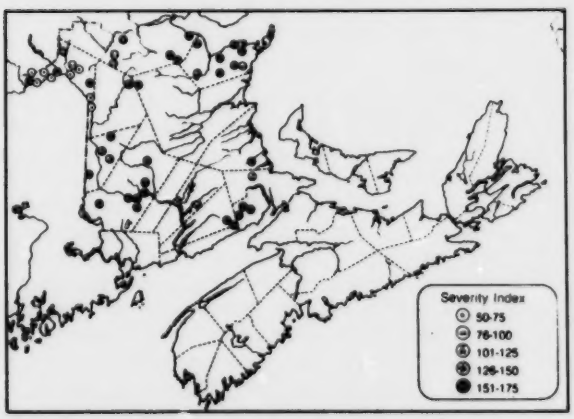


**Figure 12.** Condition of sugar maple in the Maritime Provinces in 1986.

Although this preliminary survey overemphasized branch dieback due partly to the wide range of the 1–25% dieback class, maple trees appear to be in generally good condition in most parts of the province. The initial indication from a second, more detailed, phase of this project is that less vigorous trees appear in small pockets, especially west of Fredericton. No explanation is yet offered for this occurrence, however, forest tent caterpillar must have had some impact on tree condition in the areas affected by the recent outbreak.

Table 7. The condition of maple in sugarbush areas of New Brunswick in 1986[a]

| Tree condition classes | Percent of trees in the various classes (%) | |
|---|---|---|
| | Sugar maple[a] | Red maple[b] |
| Healthy | 22.5 | 14.1 |
| Twig dieback only | 31.5 | 29.0 |
| Branch dieback 1–25% | 39.9 | 41.3 |
| 26–50% | 4.4 | 10.7 |
| 51+ % | 1.2 | 4.0 |
| dying | 0.2 | 0.3 |
| Dead | 0.3 | 0.6 |

[a] Based on a survey of 48 stands, 50 trees each
[b] Sugar maple trees: 2073, red maple trees: 327

## Quebec

Observed since the early 1980s, maple dieback continues to concern maple growers and the forestry community in general, and is the most important problem in Quebec hardwood forests.

The Applied Research Service of the Quebec Department of Energy and Resources has conducted research since 1983 to determine the causes of maple dieback, to define any correlation between biological and physical variables and the rate of dieback, and to seek means of stopping or reducing this phenomenon. From 1983 to 1985, a network of 196 semipermanent sample plots was established over an area extending from Rivière du Loup to Châteauguay on the south shore of the St. Lawrence and from Quebec City to Hull on the north shore. In 1986, 45 new sample plots were established to cover the entire range of the maple forest. This network now covers Quebec from Matane to Valleyfield on the south shore of the St. Lawrence and from Montmorency to Ville Marie on the north shore of the St. Lawrence.

Physical and biological parameters are measured in each of these sample plots. In many of these units,

experiments on heating, fertilization, and microbiology are in progress. The Insect and Disease Protection Service of the Quebec Department of Energy and Resources is participating in this research by assessing the dieback rate of each tree in the plots and noting the various stem defects as well as the presence of insects and diseases. The state of health of the 45 new sample plots was thus determined following analysis of the approximately 3000 trees being studied. Thirty of these sample plots were found to have between 6 and 25% of their foliage missing while six sample plots were missing less than 5% of their foliage (Table 8). In the areas studied during the summer of 1986, no stands were missing more than 51% of their foliage.

Table 8. Distribution by dieback class of the 45 sample plots established in 1986.

| Dieback classes (% of missing foliage) | Sample plots Number | Percentage |
|---|---|---|
| 5% or less | 6 | 13 |
| 6% to 25% | 30 | 67 |
| 26% to 50% | 9 | 20 |
| Total | 45 | 100 |

The provincial Insect and Disease Protection Service in 1986 also continued its aerial survey to determine the scope and severity of dieback in Quebec maple stands (Figure 13). The helicopter flyover was conducted from July 28 to August 29 and covered an area of 44 295 km². Maple forests between Mont Tremblant Park and Quebec City, Saint Pascal (Kamouraska) and Matane, as well as the area north of the zone surveyed in 1985, between the municipalities of Victoriaville and Saint Pascal (Kamouraska), were covered in the aerial survey. Maple forests covered a total of 6 213 km² (14%) of the overall survey area.

Assessment of the level of crown dieback was based, as in previous surveys, on the average proportion of missing foliage over the entire stand. Four classes of dieback were used: 10% or less (healthy or slightly affected); 11 to 25% (light); 26 to 50% (moderate); and 51% or more (severe). No distinction was made in collecting data between slightly affected maple stands (1 to 10% of foliage missing) and healthy stands, because it was impossible to distinguish this lowest class of dieback aerially from any other "normal" natural phenomenon that might affect the appearance of foliage.

Aerial survey results are collated in Table 9. The data show that nearly 44% of the maple stand area surveyed by air fell into the "healthy or slightly

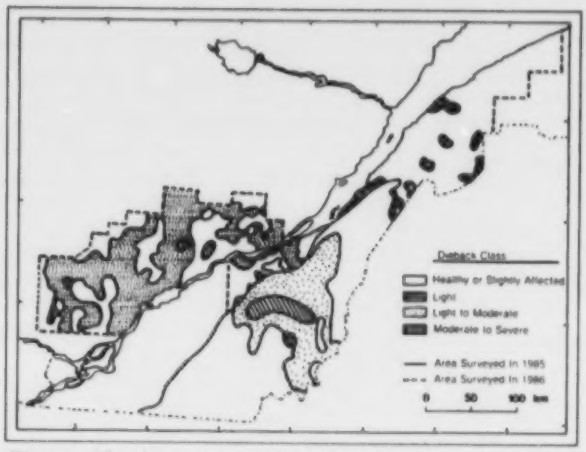


**Figure 13.** Aerial survey of the scope and severity of dieback of maple stands in central and eastern Quebec.

affected" dieback class and that damage recorded was primarily light. North of the St. Lawrence River, the level of dieback proved almost identical in each of the regions surveyed (Quebec City, Trois Rivières, and Montreal), with "healthy or slightly affected" and "light" dieback levels accounting for about 35% and 60% respectively in each region. A slightly greater proportion of dieback in the Quebec City region resulted in moderate damage. Part of this area surveyed by air, however, is located on the south shore of the St. Lawrence near the heavily affected zone evaluated in 1985.

Results from the aerial survey conducted in the Gaspé/Lower St. Lawrence Region indicate that dieback has not yet reached significant levels, because nearly 81% of the maple stand area falls into the "healthy or slightly affected" class. Stands with an assessed moderate or severe dieback level have generally been partially harvested or are dispersed within clearcut areas. This higher level of dieback intensity has also been associated with harvesting activity in several other administrative regions.

Approximately 189 observation stations were established for a general field survey, which was conducted primarily to assess the level of dieback in maple stands included in the aerial survey. Collected data indicate that 99% of the evaluated sites are at trace or light levels. This validation of the aerial survey made it possible to establish, from 69 maple stands, the average level of missing foliage in the dieback classes determined by aerial survey. This level was in the order of 7% in the "healthy or slightly affected" aerial survey class, and 14% in the "light" class. None of the observation stations was located in zones with moderate or severe dieback levels. The results of the aerial survey, combined with the field evaluation, ultimately revealed dieback to be

Table 9. Maple stand area (ha) affected by dieback in the zone covered by aerial survey in 1986.

| Administrative regions | Management units | Dieback classes: Healthy or slightly affected (10% or less) (ha) | (%) | Light (11 to 25%) (ha) | (%) | Moderate (26 to 50%) (ha) | (%) | Severe (51% and over) (ha) | (%) | Total (ha) | (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gaspé/Lower St. Lawrence | 11 | 72 146 | 80.8 | 14 006 | 15.7 | 2 483 | 2.8 | 650 | 0.7 | 89 285 | 100.0 |
| | 12 | 14 421 | 80.6 | 2 729 | 15.2 | 708 | 4.0 | 44 | 0.2 | 17 902 | 100.0 |
| | 15 | 2 882 | 74.6 | 751 | 19.5 | 176 | 4.6 | 50 | 1.3 | 3 859 | 100.0 |
| | **Total** | **89 449** | **80.6** | **17 486** | **15.7** | **3 367** | **3.0** | **744** | **0.7** | **111 046** | **100.0** |
| Quebec City | 31 | 20 857 | 34.5 | 35 592 | 58.9 | 3 870 | 6.4 | 132 | 0.2 | 60 451 | 100.0 |
| | 32 | 394 | 5.0 | 6 371 | 80.9 | 1 107 | 14.1 | — | — | 7 872 | 100.0 |
| | 34 | 12 402 | 40.4 | 15 458 | 50.3 | 2 782 | 9.0 | 94 | 0.3 | 30 736 | 100.0 |
| | 35 | 7 507 | 35.8 | 12 114 | 57.7 | 1 352 | 6.4 | 18 | 0.1 | 20 991 | 100.0 |
| | **Total** | **41 160** | **34.3** | **69 535** | **57.9** | **9 111** | **7.6** | **244** | **0.2** | **120 050** | **100.0** |
| Trois Rivières | 41 | 43 914 | 34.0 | 80 815 | 62.7 | 3 786 | 2.9 | 439 | 0.4 | 128 954 | 100.0 |
| | 42 | — | — | 125 | 100.0 | — | — | — | — | 125 | 100.0 |
| | **Total** | **43 914** | **34.0** | **80 940** | **62.7** | **3 786** | **2.9** | **439** | **0.4** | **129 079** | **100.0** |
| Montreal | 61 | 64 045 | 45.9 | 71 322 | 51.1 | 3 927 | 2.8 | 276 | 0.2 | 139 570 | 100.0 |
| | 62 | 30 838 | 25.7 | 86 329 | 72.0 | 2 528 | 2.1 | 178 | 0.2 | 119 873 | 100.0 |
| | **Total** | **94 883** | **36.6** | **157 651** | **60.7** | **6 455** | **2.5** | **454** | **0.2** | **259 443** | **100.0** |
| Outaouais | 72 | 1 644 | 95.3 | 81 | 4.7 | — | — | — | — | 1 725 | 100.0 |
| | **Total** | **1 644** | **95.3** | **81** | **4.7** | **—** | **—** | **—** | **—** | **1 725** | **100.0** |
| **Total** | | **271 050** | **43.6** | **325 693** | **52.4** | **22 719** | **3.7** | **1 881** | **0.3** | **621 343** | **100.0** |

generally at weak levels but present throughout the area surveyed in 1986. The provincial Insect and Disease Protection Service will continue its field evaluation of maple dieback in 1987, and will conduct an aerial survey of lands west of Mont Tremblant, as far as Témiscamingue.

## Ontario

Since 1984 the Ontario FIDS Unit has monitored 34 sugar maple stands across southern Ontario for the presence of dieback or decline symptoms. The original, overall results indicated that 6% of the trees showed severe decline symptoms and 16.7% showed minor symptoms. In all cases the damage was the normal result of insect, disease, or abiotic factors. Since that time, no further deterioration has been observed in any of the 34 stands and indeed, in 1983 an improvement in tree condition was observed in a few areas. The 1986 survey revealed that all of the original stands were in generally good condition with stands in the Algonquin Region exhibiting a noticeable improvement in overall tree vigour.

In addition to the above, numerous other stands are routinely examined as part of daily FIDS survey work. Several areas in Kincardine and Osprey townships, Owen Sound District, have been found where single and small clumps of sugar maple exhibited thin crowns and some branch mortality. A dieback disease *Diplodina acerina* (Pass.) B. Sutton, was collected from one of these areas.

## Red Oak Decline

For the past 10 years the Ontario FIDS unit has maintained 13 permanent sample plots of 100 trees each to monitor the course of oak decline in the southern part of Ontario, and to determine some of the factors involved in the problem. The phenomenon became apparent in the mid-1970s during the course of an outbreak of the oak leaf shredder which has since subsided. About 144 trees or 11% of the original 1300 have died since the plots were established. Of these trees, 14 succumbed in 1986. In spite of this, surveys in the past several years have shown an overall improvement in the condition of the surviving trees coincident with the subsidence of oak leaf shredder populations.

## Deterioration of White Birch

The deterioration of white birch along the Bay of Fundy is discussed in the following chapter, "Acid Rain National Early Warning System."

# Acid Rain National Early Warning System

Acid rain has been a global concern for the past few years and the effects of impurities in the air, on lakes, buildings, and the forest are becoming more apparent in many parts of the world.

Acid rain means more than just rain with lower than normal pH falling from clouds that come from elsewhere. It includes any form of acid, both wet and dry, precipitation, and air pollutants of different kinds from both near and far. These, alone or in combination, directly or indirectly, affect the health of Canada's forests by interfering with their normal development, the production of wood, or with their role in providing a healthy environment.

Concern over the future of the Canadian forests has intensified as a result of the alarming tree mortality observed in other parts of the world. The Acid Rain National Early Warning System (ARNEWS) came into being in the early part of 1984, when the Canadian Forestry Service established a national program to detect, clearly and accurately, early signs of acid rain damage to Canada's forests before damage becomes obvious.

The objectives of the program are:

1. To detect possible damage to forest trees and soils caused by acid rain or to identify the damages sustained by Canadian forests (trees and soils) which are not attributable to natural causes or management practices;

2. Long-term monitoring of vegetation and soils to detect future changes attributable to acid deposition and other air pollutants in representative forest ecosystems.

The Forest Insect and Disease Survey was charged with the responsibility for (1) plot establishment, (2) above-ground parameter monitoring and sampling, (3) providing assistance in obtaining foliage and soil samples for chemical analysis.

Permanent plots are to be maintained in all regions of Canada (Figure 14) to monitor:

a. the condition and changes in the conditions of the forest stand,
b. the presence and fluctuation of biotic and abiotic factors that affect the condition of the forest (insects, diseases, stand changes, temperature, etc.),
c. the changes and symptoms that indicate factors not attributable to the above that could conceivably be early signs of acid rain damage, and
d. the effect of acid rain on the condition of the various economically important tree species.

The rationale behind the above is that without close monitoring of all of the factors mentioned, the expected, initially subtle, effects of acid rain cannot be isolated and identified. By the end of 1986 FIDS had established 106 plots of the ARNEWS network across Canada. Tree and ground vegetation measurements and condition were taken, and soil and foliage sampling and analysis were completed for some plots.

## Newfoundland

Permanent ARNEWS sample plots were monitored during a two-week period in September. Tree assessment, ground vegetation, and a regeneration survey were conducted. Soil samples were also taken. A forest fire destroyed the plot near Bay d'Espoir but it will be re-established in adjacent areas in 1987.

## Maritime Provinces

In the Maritimes Region, 15 permanent ARNEWS plots, representing the important forest species and geographical areas were established in 1984. Two additional plots were established in northwestern New Brunswick in 1985 at the request of and in cooperation with Fraser Inc. (Figure 14). These will be monitored jointly with the Company in future years.

In 1986, all plots were visited monthly from June to September to determine forest insect and disease conditions, detect "acid rain" symptoms (if any), observe seed crop and premature fall discoloration, to collect ground vegetation samples, and to sample lichens and mosses found on trees. In August, detailed assessments of all plots were carried out following the procedures developed by the Maritimes FIDS unit for the national system.

Foliage samples from conifers are now available for analysis from eight ARNEWS plots, from hardwoods from five plots, and soil samples from four plots. Information from increment cores collected in 1984 has been computerized, in cooperation with the Petawawa National Forest Institute, and preliminary analysis started (10 cores per species per plot constituting at least 10% of stand).

Tree mortality on all ARNEWS plots increased to 11.4% in 1986, compared to 9.3% in 1985 and 8.3% in 1984.

In addition to the work on permanent plots, the results of observations for signs of possible acid rain damage were recorded for most of the 280 locations where detailed pest condition assessments were made. Special attention was directed to the number of years of needle retention on coniferous species. The percentage of needles retained decreased with age of foliage and the rate of the decrease varied among tree species and between provinces. It is

important to realize that the figures represent provincial averages and, more important, that at least some of the loss is definitely attributable to feeding by defoliation insects. Similar information was collected in 1985 in an effort to build a data base which will allow analysis of possible changes.

Forest Insect and Disease Survey personnel are always on the lookout for unusual or unexplained forest conditions, some of which are conceivably suspect for acid rain damage.

In 1985, in the course of general aerial surveillance, an unexplained deterioration of white spruce was observed in northern New Brunswick. The condition involved areas of several hundred hectares in the vicinity of Squaw Cap (elevation 483m), Slate Mountain, and Mann Mountain in Restigouche County. Mainly mature trees were affected but other age classes were also deteriorating to some extent. Upon further investigation in 1986, this condition proved to be due to insect damage.

Also in 1985, in the southern part of New Brunswick, red spruce was found in a deteriorating condition at many locations on Deer Island, Charlotte County. Although trees in many of these areas have been defoliated by the spruce budworm in the past this does not adequately explain the conditions observed. In 1986, permanent observation plots, each consisting of 50 trees, were established in Charlotte and Sunbury counties in New Brunswick and in Hants, Cumberland, and Halifax counties in Nova Scotia to follow changes in the condition of trees. The summary of the tree conditions at the five plots is presented in Table 10 and constitutes only baseline information without comment.

The detoriation of white birch along the Bay of Fundy was first noticed in 1978. The condition has been under surveillance and has been reported annually since 1979. In 1986, research was initiated to determine if "acid rain" is a causual factor in the annual occurrence of foliage browning and early leaf fall in this area.

## Deterioration of white birch along the Bay of Fundy

Since 1979, early leaf browning and premature leaf drop of white birch has occurred annually in southern New Brunswick and, in some years, in western Cumberland County, Nova Scotia, along the Bay of Fundy. Browning, severe every year with the exception of 1982, develops quickly and is characterized by chocolate-brown discoloration and a scorch-like appearance, which at times is restricted to leaf margins. The affected leaves curl and start dropping as early as mid-August. It was observed that leaves that develop in the latter part of the season often remain green while older leaves on the same twig turned brown. Although mainly a condition of white birch, similar symptoms were observed in 1980 and 1981 on other deciduous vegetation including alder, mountain ash, and mountain maple. The condition occurs along a coastal strip of 1 to 15 km wide and extends inland as far as 30 km, mainly along low lying areas.

In 1986, the condition was present again in essentially the same areas as in previous years, however, there was a marked reduction in the intensity of browning compared to 1985. The initial symptoms of leaf discoloration appeared later in the summer than usual and the condition was more patchy in nature than in previous years. Foliage insects and diseases of birch were again present throughout the area, but none of these, alone or in combination, accounted for all of the discoloration. The only visible difference in conditions in 1986 was the more than the usual amount of cloud cover, consequently less sunshine. However, because the cause of this condition on white birch is unknown, this comment is offered more as an observation than an explanation. In addition to leaf browning along the Bay of Fundy Coast in New Brunswick, trace to moderate discoloration of white birch also occurred on the Nova Scotia side of the "tip of the Fundy funnel" from Joggins to Eatonville, Cumberland County.

Table 10. Condition of red spruce at five permanent plots in the Maritimes in 1986.

| Tree condition class | Percentage of trees in various tree condition classes | | | | |
|---|---|---|---|---|---|
| | New Brunswick | | Nova Scotia | | |
| | Charlotte Co. | Sunbury Co. | Hants Co. | Cumberland Co. | Halifax Co. |
| 1 Healthy, no defoliation | 4 | 0 | 14 | 0 | 100 |
| 2 Healthy, only current defoliation | 38 | 0 | 0 | 0 | 0 |
| 3 More than current but less than 25% total defoliation | 50 | 64 | 46 | 12 | 0 |
| 4 Total defoliation 26–50% no bare top | 6 | 28 | 36 | 74 | 0 |
| 5 Total defoliation 26–50% with bare top | 2 | 8 | 4 | 14 | 0 |

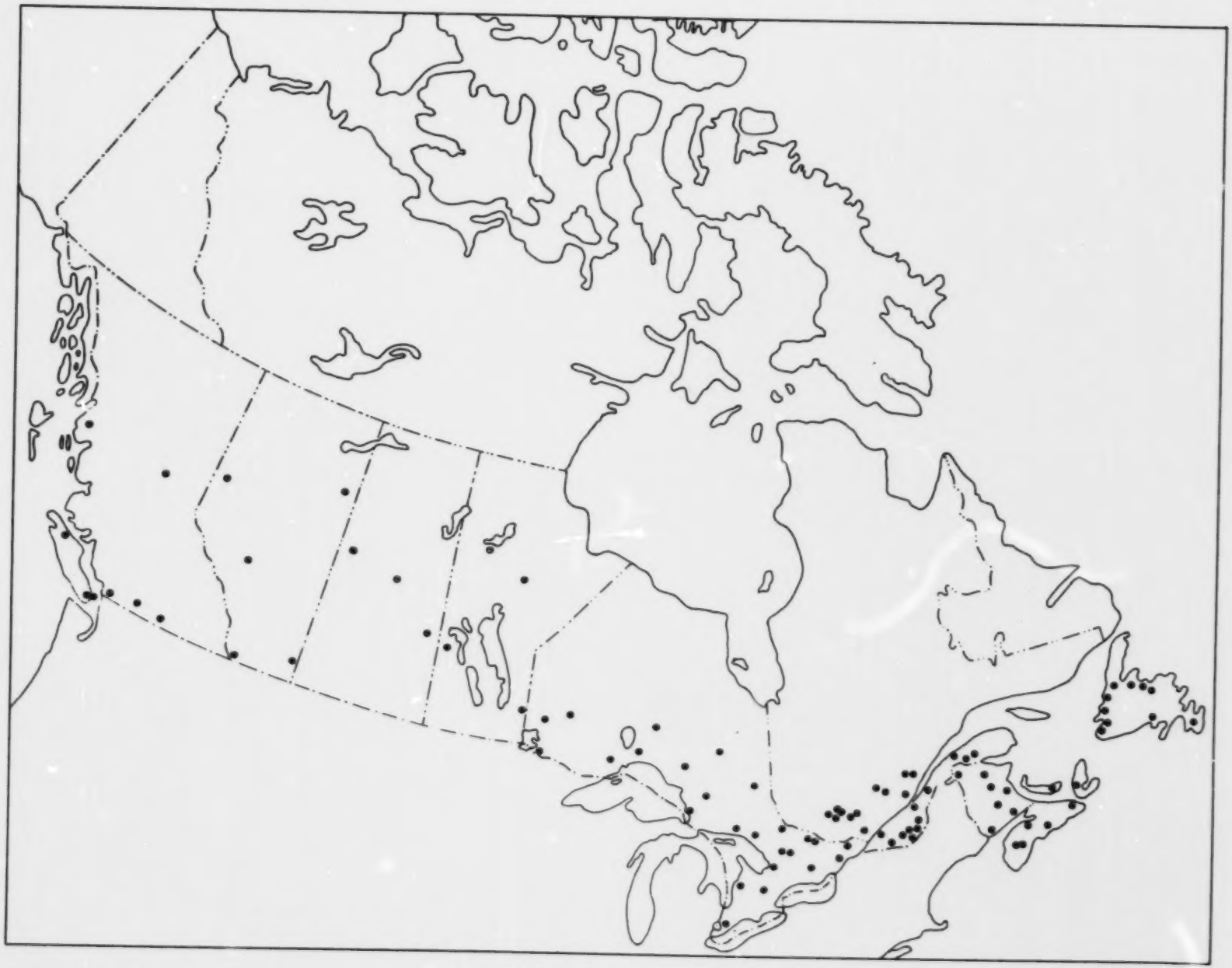

**Figure 14.** Acid Rain National Early Warning System — location of plots.

White birch is in very poor condition in some of the affected areas. The foliage is thin even before the early browning appears. Crown dieback, with dead twigs and branches, is evident and many trees are dead. The condition of trees has been assessed annually on a series of permanent plots established to follow the deterioration of white birch in this area. The difference in the condition of trees between 1982 (when the plots were established) and 1986 indicates that there is indeed an effect of repeated early browning and premature leaf fall (Table 11) on the 11 New Brunswick plots. The cause of foliage discoloration and deterioration of white birch remains unknown. Several organisms are associated with this condition but none of them, alone or in combination, satisfactorily explains the situation.

Table 11. Change in tree condition of white birch along the Bay of Fundy in New Brunswick on 11 permanent plots between 1982 and 1986.

| Tree condition class | % of trees in class | |
|---|---|---|
| | 1982 | 1986 |
| No dieback | 92.9 | 14.5 |
| Twig dieback only | 1.5 | 47.3 |
| Twig and branch dieback | 4.7 | 31.3 |
| Tree mortality | 0.9 | 6.9 |

Each plot consists of 50 tagged trees.

The leaf spot fungus *Septoria betulina* has been consistently present each year on the affected trees and in 1982, when the condition was least severe, accounted for much of the leaf browning. This fungus is known to have caused severe browning elsewhere in the past but not on such a large scale and not for such an extended period. Its association with the condition is an inescapable fact. However, where the fungus is present on white birch in other parts of the Maritimes, the symptom expression is different from that found along the Bay of Fundy. Further, *S. betulina* does not account for the leaf browning observed on other vegetation. In 1986, Septoria leaf spot was again present but was not as common as in recent years and was found associated with severe leaf browning only at Dark Harbour, Grand Manan Island, Charlotte County; Lepreau Falls, Tynemouth Creek, and Martin Head, St. John County; and at 45 Mile Road in Fundy National Park, Albert County.

In other areas of the Region, Septoria leaf spot and associated browning occurred on Cape Breton Island, Nova Scotia, on the French, North, and MacKenzie Mountains in the Cape Breton Highlands National Park, in areas of Inverness County, on the mainland in southeastern Halifax County and to a much lesser extent in pockets elsewhere. Browning was variable, affected mostly the younger trees and was confined mostly to the lower parts of the trees. In Prince Edward Island, light browning occurred on a few young white birch trees at two locations in Kings and Queens counties and in New Brunswick, in addition to areas already mentioned, in Kings, Sunbury, York, and Victoria counties.

To elucidate some of the possible factors that may be causing this condition, a multidisciplinary research effort was launched in 1986. Included are studies on the acidity of fog, on nutrient availability of soils, on the effect of acidity differences on the behavior of *Septoria betulina*, the monitoring of ozone levels, of the acidity of rain and the continued monitoring of tree conditions and of forest pest populations. A series of 24 additional plots were established — at 6 locations, 3 of which are coastal and 3 are inland, away from the affected area — to increase the data base and to allow manipulation of conditions on some of them.

## Quebec

In 1986, FIDS personnel inspected the 25 ARNEWS sample plots in Quebec, which are located in hardwood, softwood, and mixed stands, twice during the growing season. Visual examination of each tree in the plots has not disclosed any preliminary signs of damage caused by acid rain or resulting from infection or insect infestation. Neither symptoms nor damage have yet been seen.

## Ontario

In 1986, two new acid rain plots were established in the province bringing the total number in the Ontario portion of the national system to 27. The new plots were located in Sproule Township, in Algonquin Park and South Walsingham Township, Simcoe District. Plots are now established in strategic areas of all the acid deposition zones in the province. The stands in which the plots are established represent the major commercial tree species of the province including white spruce, black spruce, jack pine, white pine, Norway spruce, sugar maple, oak, white birch, and yellow birch. The scheduled sampling and measurements were carried out in each plot along with surveillance for insect and disease attacks and specific acid rain symptoms. Nothing unusual was found. Chemical analysis of foliage samples was completed in 1986 in soil sampling and analysis is planned for 1987.

## British Columbia

Establishment of a nationally standardized series of long term study plots in forested areas in 1984 included British Columbia because of the potential

for damage to forests from low pH rainfall (4.6 or less in south-western B.C.) and the presence of soils with low buffering capacity.

Six additional CFS-FIDS-ARNEWS plots were established in 1986 in addition to the nine established earlier. The 15 plots are distributed throughout the province as follows: Lower Vancouver Mainland — 5, Fraser Valley — 2, Vancouver Island — 2, Saltspring Island — 1, and one in each of the other five forest regions near Penticton, Castlegar, Quesnel, Prince George, and Terrace.

Baseline knowledge from the 1/25-ha plots currently being evaluated includes the concentration of foliar and soil elements, foliar condition, insect or disease occurrence, tree growth and, on selected plots, the incidence and possible changes of sensitive lichens and liverworts.

Additional observations for possible acid rain or other mimicking symptoms have been made by FIDS rangers at 592 permanent sample sites (PSS) since 1984. Trees were generally healthy in most (90%+) of the PSS's and damage observed was usually identifiable as caused by previous or current pest activities. Symptoms directly attributable to acid rain, including premature needle discoloration and needle loss, have not been seen to date.

Premature loss of older needles in mature western hemlock was observed over about 240 ha on the east side of Neroutsos Inlet about 1 km north of the Port Alice pulp mill. Foliar discoloration symptomatic of sulphur dioxide damage was also observed on alder and some ground cover plants.

## Prairie Provinces

Ten ARNEWS plots established in Alberta (four), Saskatchewan (two), and Manitoba (four) in 1985 were re-monitored by FIDS staff. Two new plots were established; one near Fort McMurray, Alberta and the other near Hudson's Bay, Saskatchewan. Soil and foliage samples for chemical analyses will be completed in 1987. No major insects and disease problems were detected in the plots monitored.

# Special Surveys

## Cone and seed pests

### Maritime Provinces

The establishment of seed orchards created a new category of high value areas in the Maritimes Region. Seed orchard and seed production are as important to nursery programs as seedling production in nurseries is to plantation programs. Consequently, anything that interferes with seed orchards also affects most other phases of forestry operations aimed at future wood production. Forest pests in seed orchards, both insects and diseases, have the potential to seriously affect seed production, either directly, by destroying seed or cones, or indirectly, by affecting the condition of trees, thus interfering with their ability to produce seed. The following, which is not intended to be all inclusive, was gathered with the cooperation of R. Smith, CFS-Maritimes, and various seed orchard managers.

***Insects:*** — Spruce cone maggot (*Hylemya anthracina*) (Czerny) infesting 5 to 90% of cones on a number of white spruce grafts in Nova Scotia, and a pine cone beetle (*Conophthorus* sp), in southeastern New Brunswick were the only insects found in 1986 directly affecting cones.

Insects, with effect on trees rather than directly on cones: the eastern spruce gall adelgid (*Adelges abietis* (L.), formed 4 or 5 galls per tree on 25–30% of white spruce grafts in Nova Scotia; aphids, (*Cinara* sp.) infested 50% of the trees in an eastern white pine seed production stand in Nova Scotia, 50% of the trees in a larch stand in New Brunswick, and were found on 2% of the trees in a white spruce stand in Nova Scotia; larch shoot moth, (*Argyresthia laricella* Kft.), was common on larch in New Brunswick.

Other insects found in seed orchards included the spruce budworm (*Choristoneura fumiferana* (Clem.)), spruce bud scale (*Physokermes piceae* (Schr.)), and spruce spider mites (*Oligonychus* sp), on spruce, the northern pitch twig moth (*Petrova albicapitana* (Busck)) on pine, and the orange larch tubemaker, (*Coleotechnites laricis* (Free.)) on larch.

***Diseases:*** — Cone rust (*Pucciniastrum americanum* (Farl.) Arth.) was found on white spruce at very low levels in four areas in the Region. This rust, which was present at epidemic proportions in 1984, can be a destructive disease. It was the only disease directly affecting cones.

Sirococcus shoot blight (*Sirococcus conigenus* (DC.) P. Cannon & Minter) infected 60% of the red pine trees in a residual stand within a southern New Brunswick seed orchard. This stand was harvested in 1986 to prevent the disease from infecting seed orchard trees. A spruce needle rust (*Chrysomyxa ledi* dBy.) was present on 90% of white spruce trees, affecting from 1 to 30% of the needles, in a Nova Scotia seed orchard and in another orchard in that province, 5–10% of the trees were affected at trace level. A needle rust on larch (*Melampsora medusae* Thuem.) infected 10% of the trees at a New Brunswick location.

### Quebec

For the sixth consecutive year, the Insect and Disease Protection Service of the Quebec Department of Energy and Resources conducted a survey of insects affecting forest species that are used primarily for reforestation. The primary objective of this survey was to gather as much information as possible on the identification and relative importance of these pests.

This year, a total of 8254 cones from white spruce, black spruce, Norway spruce, jack pine, red pine, and Scots pine was examined. (Table 12). Results indicate a decline in the number of species found, in comparison with the 2 previous years, as well as a slight reduction in the general frequency of infestation.

The spruce cone maggot, *Delia anthracina*

Table 12. Distribution of cones examined in the last 3 years

| Species | Number of cones examined | | | Number of cones with insect activity | | |
|---|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1984 | 1985 | 1986 |
| White spruce | 3 458 | 168 | 1 993 | 720 | 50 | 1 103 |
| Black spruce | 2 331 | 950 | 1 056 | 395 | 247 | 227 |
| Norway spruce | 310 | 60 | 398 | 62 | 4 | 11 |
| Red pine | 530 | 1 982 | 2 177 | 51 | 198 | 240 |
| Jack pine | 487 | 1 755 | 1 830 | 12 | 35 | 37 |
| Scots pine | 250 | 778 | 800 | 0 | 8 | 1 |

(Czerny), which ranges all across the continent, was highly active this year. Its presence or damage was observed in 999 white spruce cones and 216 black spruce cones, representing, respectively, 90% and 95% of all white spruce and black spruce cones in which the presence of insect activity was noted. It should be noted that one larva of this dipterous insect can destroy up to 55% of the seeds in a cone; where infestations are severe, therefore, 100% of the seeds can be destroyed.

## Ontario

In 1986 cone and seed surveys were carried out on black spruce in northern Ontario. The survey was conducted to determine the pests affecting cone and seed production on this species and to gather baseline data on these agents. Each ranger in the Northern, North Central, and Northwestern regions attempted to make two collections of 100 cones, one each from an upland and lowland site.

A total of 1296 cones were examined of which 19% were damaged. Actual seed loss within the total sample was about 8%. The principal agents causing the damage included the spruce cone maggot, *Hylema anthracina* Czerny; the spruce cone axis midge, *Dasineura raciphaga* Tripp; the spruce cone gall midge, *Dasineura canadensis* Felt; the white pine coneworm, *Eucosma tocullionana* Heinr.; the spruce seed chalcid, *Megastigmus atedius* Wlk.; and unknown lepidoptera. Some cones also suffered mechanical damage. A summary of the results is included in Table 13.

A survey of the pests of white pine cones and seeds was the southern Ontario counterpart of the northern Ontario black spruce cone and seed survey. In this survey each ranger in southern Ontario,

Table 13. Summary of black spruce cone and seed damage at 13 locations in northern Ontario in 1986

| District | Location and site | No. of cones examined | Cones damaged % | Seed loss within damaged cones % | Principal causes of damage |
|---|---|---|---|---|---|
| Red Lake | Dixie Lake Rd (Lowland) | 100 | 2 | No seed loss | 1. White pine cone borer<br>2. Lepidoptera |
| Sioux Lookout | McAree Twp (Upland) | 100 | 36 | 57 | 1. Spruce cone maggot<br>2. Lepidoptera<br>3. Unknown |
| Fort Frances | Moose Lake (Lowland) | 100 | 12 | 34 | 1. Spruce cone maggot<br>2. Lepidoptera |
| Dryden | Satterly Twp SPA (Upland) | 100 | 41 | 38 | 1. Lepidoptera<br>2. Unknown<br>3. Spruce cone maggot |
| Thunder Bay | Hwy 527 (Lowland) | 100 | 3 | 8 | 1. Unknown<br>2. Spruce seed midge |
| Nipigon | Sterling Twp (Upland) | 100 | 2 | 41 | 1. Unknown<br>2. Spruce cone maggot |
| Geraldton | Kimberly-Clark SPA (Upland) | 99 | 10 | 15 | 1. Spruce seed maggot<br>2. Lepidoptera |
| | Oakes Twp (Lowland) | 98 | 11 | 47 | 1. Unknown<br>2. Spruce cone axis midge<br>3. Lepidoptera |
| Chapleau | Sandy Twp (Lowland) | 100 | 21 | 47 | 1. Spruce cone maggot<br>2. Unknown<br>3. Spruce seed midge |
| Gogama | Invergarry Twp (Upland) | 100 | 15 | 29 | 1. Spruce cone maggot<br>2. Unknown |
| Kirkland Lake | Gross Twp (Lowland) | 100 | 45 | 51 | 1. Spruce cone maggot<br>2. Spruce cone axis midge |
| | Burt Twp (Upland) | 99 | 14 | 16 | 1. Spruce cone maggot<br>2. Unknown |
| Kapuskasing | Fauquier Twp (Lowland) | 100 | 30 | 71 | 1. Spruce cone maggot<br>2. Spruce cone axis midge |

Table 14. Summary of white pine cone and seed damage at seven locations in southern Ontario in 1986.

| District | Location (Twp) | No. of cones examined | Cones damaged % | Seed loss within damaged cones % | Principal causes of damage |
|---|---|---|---|---|---|
| North Bay | Gurd | 85 | 34 | 18 | 1. Resin midge<br>2. White pine coneworm |
| Blind River | Kirkwood | 100 | 9 | 14 | 1. Unknown<br>2. Resin midge |
| Bracebridge | Macaulay | 90 | 23 | <1 | 1. White pine coneworm<br>2. Jack pine budworm |
| Pembroke | Wylie | 100 | 40 | 16 | 1. Resin midge<br>2. White pine coneworm<br>3. White pine cone beetle |
| Carleton Place | Gloucester | 100 | 12 | 5 | 1. Unknown<br>2. Resin midge<br>3. White pine coneworm |
| Huronia | Vespra | 100 | 32 | 21 | 1. White pine coneworm<br>2. Resin midge |
| Simcoe | Charlotteville | 43 | 88 | 38 | 1. White pine coneworm<br>2. Resin midge |

including the Northeastern Region, attempted to collect 100 still green, second-year white pine cones. A total of 618 cones was examined at the Sault Ste. Marie laboratory of which 181 or 29% were damaged. Overall seed loss within the damaged cones averaged 26%. The principal agents causing the damage were as follows: the white pine coneworm, *Eucosma tocullionana* Heinr.; the white pine cone beetle, *Conophthorus coniperda* (Sz.); a resin midge, *Resseliella* sp.; the spruce seed chalcid, *Megastigmus atedius* Wlk.; the jack pine budworm, *Choristoneura pinus pinus* Free.; unknown lepidoptera and other unknown agents. A complete summary is contained in Table 14.

### British Columbia

Cone crops were heavy in north coastal areas, but generally light and spotty elsewhere, similar to 1985. Cone and seed pests were also variable in 39 province-wide cone bearing stands examined. Major pests included Douglas-fir seed chalcid, *Megastigmus spermotrophus* Wachtl., which infested up to 45% of the cones in parts of the Nelson Region and in four coastal seed orchards. The spruce cone maggot *Delia anthracina* (Czerny), infested up to 75% of the white and Engelmann spruce cones in six interior stands and in a Sitka spruce seed orchard on Vancouver Island, and 78% of the cones in 18 natural Sitka spruce stands in the western part of the Prince Rupert Region. Western hemlock cones in five north coastal areas were healthy, as were yellow cedar cones from Rennel Sound on the Queen Charlotte Islands.

Surveys of provincial and industrial seed orchards identified several pests, generally at low levels, in 12 coastal and 3 interior seed orchards. Cooley spruce gall aphid, *Adelges cooleyi* (Gill.), severely infested Douglas-fir in 11 coastal orchards and lightly infested white and Englemann spruce in one interior orchard. Balsam woolly aphid, *Adelges piceae* (Ratz.), infested twigs on about 5% of the amabilis fir in three orchards on Vancouver Island, all within the known infestation zone. Swiss needle cast, *Phaeocryptopus gaeumannii* (Rohde) Petr., was less severe and extensive than in 1985 but infected 10% and 50% of the Douglas-fir in two coastal orchards. White and Engelmann spruce in two orchards near Kamloops were again lightly infested by western spruce budworm, *Choristoneura occidentalis* Free., which has been epidemic in adjacent Douglas-fir stands. Stem rusts, *Cronartium coleosporioides* Arth., and *Endocronartium harknessii* (J.P. Moore) Y. Hirat., persist and pine needle disease, *Lophodermella concolor* (Dearn.) Darker, infected about 10% of the needles in provenance trials south of Prince George.

## Pests and diseases in young stands and plantations

### Newfoundland

Several black spruce plantations throughout central Newfoundland showed varying degrees of reddening of needles with the most severe damage

occurring at Springdale and West Bottom Road. The Spruce spider mite, *Oligonychus ununquis* (Jacobi), was present in moderate to high population levels in these plantations. This mite is considered one of the important pests of spruce plantations in some parts of Canada, but the roles of other possible contributing factors, including acute weather, poor soil nutrient status, and disease organisms are being investigated.

## Maritime Provinces

The increasing importance of planted trees in forest management resulted in the initiation of an annual plantation assessment program in 1982. The lessons learned from agriculture and from experience with large-scale forest plantings suggest that tracts of even-aged, single species forests will bring with them special pest problems. Previously insignificant pests may take on new importance and many of the well-known pests may change their habits in the new environment. Among these are the spruce bud moth, Sirococcus shoot blight, Armillaria root rot, needle rust on jack pine, mites and seedling debarking weevil. As our knowledge of pest outbreaks in plantations accumulates, our methods of establishing and tending them must incorporate ways to offset the effects of such pests, if we wish to avoid or minimize losses.

The first large scale joint plantation survey in New Brunswick between the provincial Department of Natural Resources and Energy and the Forest Insect and Disease Survey of the Canadian Forestry Service — Maritimes took place in 1985 to assess the general state of health of plantations and of silviculturally treated (thinned) areas. There were large-scale joint surveys conducted in the past, but all previous surveys were pest specific in response to crisis situations, such as the Scleroderris survey in 1979, in the wake of the discovery of the European race of that disease in the province. The survey in 1985 was conducted as a pilot project in anticipation of regular, continuing surveys in future years.

In 1986, the Department of Natural Resources and Energy (DNRE) and the Forest Insect and Disease Survey were joined by two of New Brunswick's larger forest companies, J.D. Irving Ltd., and Fraser Inc., in carrying out extensive pest assessment surveys in plantations. To ensure uniformity and standardization, both field and classroom instruction courses were conducted in advance of the actual field work.

There were 141 plantations assessed by DNRE, J.D. Irving Ltd., and Fraser Inc. DNRE also assessed 14 thinned areas. Fifty-nine percent of the areas selected were visited twice. Observations were made on the type and the level of disturbances or damage caused by forest pests. Field assessments were carried out by staff of the three organizations. Identification of samples and data analysis were done by the Forest Insect and Disease Survey.

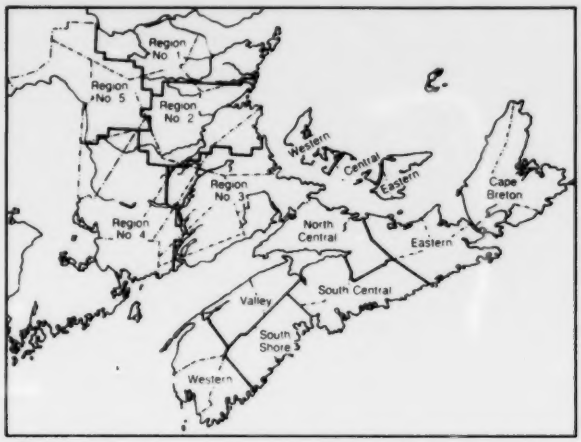


**Figure 15.** Forest inventory units of the provincial forest services in the Maritime Provinces.

There were 245 assessments made in the 141 plantations and 14 silviculturally treated areas. A total of 12 250 trees was examined.

A brief summary of the results of the New Brunswick survey is offered here:

1) The most remarkable — and comforting — observation drawn from the results is that, in spite of a long list of organisms encountered, plantations of both spruce and jack pine were found to be generally in very good condition in New Brunswick in 1986. An average of over 92% of both spruce and pine trees were classified as healthy.

2) Only 1.1% of the pine and 2.4% of the spruce trees were dead and tree mortality ranged from 0.3% of pine in DNRE Region 1 to 3.4% of spruce in DNRE Region 5. At least some of the tree mortality is due to Armillaria root rot.

3) Current defoliation was extremely variable among regions and ranged from 73% on spruce in DNRE Region 5 to only 8% on pine in DNRE Region 1, however, the level of defoliation was mostly trace and moderate or severe defoliation was observed on less than 1% of the trees assessed in the province.

4) Needle diseases, involving mostly needle rusts, were common, but, with the exception of DNRE Region 3, only occasionally reached light intensity. In DNRE Region 3 the jack pine needle rust was still at the highest levels in the province, but was much reduced from those that occurred in previous years.

5) Buds were found healthy on 98% of the pine and 87% of spruce trees with little variation in this condition throughout the province.

6) Leaders were healthy on 90% and 79% of pine and spruce, respectively and less than 2% were dead on either species.

7) Multiple leaders were reported on 9.2% of pine and 16.5% of spruce trees in the province. However, regional variation was so great, 3 to 18% on pine and 2 to 23% on spruce, that it is questionable whether these figures are true or represent observer bias; thus their validity is suspect.

8) Branch, stem, and root damage was reported for both pine and spruce but the level of damage was generally low. The exception was jack pine in DNRE Region 3 where 13% of the branches were damaged, probably due to a combination of globose gall rust and the northern pitch twig moth.

The 14 thinned areas assessed included 12 stands of various combinations of fir and spruce, 1 stand of jack pine and 1 hardwood stand where yellow birch was the dominant species. All stands were in good condition with 70–100% of the trees considered healthy with the exception of one fir-spruce stand in DNRE Region 5 where 66% of the trees were classified as damaged.

Sirococcus shoot blight, caused by the fungus *Sirococcus conigeus* DC) P. Cannon & Minter (previously known as *Sirococcus strobilinus* Preuss), has been known in the Maritimes since the early 1970s but has been present for much longer. The fungus infects and kills newly developed shoots. Fruiting bodies are produced on the twigs, needles, and cone scales from whence the spores disperse and cause new infection. Heavy attacks cause branch mortality, which results in crown dieback and tree mortality. In the Maritimes, the disease affects red pine and occasionally spruce and larch, although other species of pine, hemlock, Douglas-fir, and true firs can also be affected. Trees of any size, from seedlings to 15 m in height, are damaged or killed.

The initial infection in newly established plantations appears to be closely related to the proximity of older red pine stands, as 48% of young plantations less than 1 km from older red pine were found infected, compared to 8.7% which were more than 1 km away from an infection source. After the initial infection the severity of the disease increases as the trees become older.

The disease is present in all three provinces but is most widely distributed in red pine plantations in Nova Scotia, west of the Colchester-Pictou and Halifax-Guysborough county lines, and in natural regeneration in the southern half of New Brunswick.

In 1986, the disease further intensified in all three provinces. In many areas the repeated infection has resulted in serious deterioration of red pine stands and plantations, in some to the point that salvage operations were carried out.

In New Brunswick, Sirococcus shoot blight occurs mostly in the southern part of the province, although affected plantations are known as far north as the line from southern Victoria to northern Kent counties. Infection in general was at about the same level as in 1985. Some young red pine trees have died under older infected trees in Charlotte County and at Londonderry, Kings County. A mature red pine plantation, with chronic moderate and severe infection, which had seriously deteriorated was cut in 1986. About 20% of the red pine trees in a mixed area of red pine-jack pine-spruce were infected near a seed orchard at Parkindale, Albert County.

In Nova Scotia, infected red pine stands in Cumberland, Colchester, Hants and Yarmouth counties continued to deteriorate. The disease increased in intensity at Diligent River, Cumberland County, where it was first found in 1985. Severe shoot browning occurred in a small plantation near Parrsboro, Cumberland County. Several new areas with severe shoot browning were found elsewhere. Infected, deteriorating stands were harvested in the Chignecto Game Sanctuary, Cumberland County, and the stand at Squid Cove, Lunenburg County, reported to have 23% mortality with the rest of the plantation infected in 1985, was also cut. In eastern Nova Scotia, the small red pine plantation in the Perch Lake road area, first reported to be infected in 1985 and surrounded by numerous healthy plantations, was cut in an effort to stop the spread of the disease. Two larch trees at Lochside, Richmond County on Cape Breton Island were found to be infected.

The deterioration of pine stands by Sirococcus shoot blight in western Nova Scotia and the spread to plantations in the eastern half of the province, where red pine has been a major plantation species in recent years, makes this disease one of the major plantation problems in Nova Scotia.

In Prince Edward Island, Sirococcus shoot blight is now known to be present at three locations: Goose River, Kings County, and Iona and Selkirk Road, Queens County. At Iona, where it was first reported on a few red pine trees in a 1-ha plantation in 1984, the number of infected shoots per tree has increased from "light" to about 60% on some of the fringe trees in 1986. At Goose River, there was a marked increase in shoot infection in a 3-ha, 22-year old red pine plantation. First reported as light on a few trees in 1985, examination in 1986 showed that virtually all trees have some degree of damage with about 5% of fringe and open growing trees supporting close to 50% shoot damage. At Selkirk Road, where the disease was observed for the first time in 1986, about 1–2% of the red pine supported from 5 to 29 damaged shoots on lower crown branches.

Spruce bud moth, *Zeiraphera canadensis* Mutuura

& Freeman, and to a lesser degree, a closely related species, *Zeiraphera unfortunana* Powell, have been omnipresent forest pests in the Maritimes since at least the late 1930s when the Forest Insect and Disease Survey started to keep records. Although widespread, insect populations have been generally low except for the occasional flare-up, usually on open-grown white spruce. The last recorded outbreak occurred in New Brunswick in the mid-1960s when spruce in parts of the Southwest Miramichi and the Nashwaak River drainage system sustained moderate to severe defoliation, and in Nova Scotia in the mid-1970s when similar levels of defoliation occurred in areas along the Northumberland Strait and the Fundy Coast.

Spruce bud moth, a not-too-important forest insect in mature forests, became a major pest in 1980 when it was discovered to be causing defoliation, shoot distortion, and tree deformation in white spruce plantations over large areas in New Brunswick. In 1982, over two-thirds of the 180 locations surveyed in the Region were infested by spruce bud moth. At over 40% of these locations, in both New Brunswick and Prince Edward Island, defoliation and shoot damage were more than 10%. Injury was classed as moderate or severe at 10 and 20%, respectively, of the locations surveyed.

In 1986, spruce bud moths were widespread in the Region and there was some increase in populations from 1985 levels in some areas.

In New Brunswick, an average of 10% of the shoots of white spruce trees were affected over much of the province, however, shoot damage as high as 60% was observed in Kouchibouguac National Park in Kent County. All trees were affected in some plantations and none in others, but 73% of the trees observed in the province had at least some damaged shoots. Moderate damage on 20% of the trees was observed in a plantation on the Little Wapske River, Victoria County.

In Nova Scotia, the average number of shoots damaged was 10%. The highest level of damage in the province was observed at Ben Eoin, Cape Breton County, where 35% of the shoots were affected on 80% of the white spruce trees. Although shoot damage was generally light in the province, an increase from 1985 levels was noted in some areas.

In Prince Edward Island, there was a marked increase in the populations levels of *Z. canadensis* while those of *Z. unfortunana* remained low throughout the province. Shoot damage at nine locations averaged about 40%, but in some young white spruce plantations, 70% of the shoots were affected. The most serious damage was observed at Granville and Brookvale, Queens County, and at Harmony Road, Prince County.

Armillaria root rot, *Armillaria mellea* (Vahl ex Fr.) Kummer, a disease of a wide variety of tree species of various ages, has always been a part of the forest disease complex in the Maritimes, but its significance appears to have changed in recent years. On the one hand, the fungus is strongly implicated among the group of secondary organisms that combine to provide the final blow to trees weakened by other factors such as repeated defoliation by the spruce budworm. On the other hand, Armillaria-infected or killed trees are becoming more frequent throughout the Maritimes, and are often observed in plantations. The increased frequency is doubtless a factor of the increase in the area planted. The implications of the root rot to the future of plantations under the climate of the Maritime Provinces are poorly understood. In some areas, groups of trees are affected and there is evidence that with the spread of the fungus these patches could increase in size. In other areas, only scattered trees are infected but these could become centers of infection if the fungus spreads. Not all infected trees die, (the fungus is primarily a wood decay organism causing root and butt rot), but its action may cause understocking in both plantations and natural stands. The fungus is also closely associated with Stillwell's Syndrome, the sudden death of balsam fir trees.

The disease is widely distributed in the Region and mortality of trees, both young and old, was again common in 1986. In New Brunswick, Armillaria root rot killed at least some trees in 22% of the 141 spruce and pine plantations surveyed during the province-wide assessments. This is 6% higher than the 16% incidence found in 1985, based on similar surveys in 70 plantations. The disease is present in all areas of the province and affects both spruce and pine. There are differences in the rate of infection among the five regions and also between the level to which the two species are affected (Table 15). Whether the differences are real or are due to differences in expertise among the observers remains to be seen, but the presence of the disease is inescapable and cause for concern. Tree mortality in the affected plantations, attributable to Armillaria root rot ranged from 2 to 8%. In Nova Scotia, the disease affected 12% of Norway spruce trees in a provenance trial north of Trafalgar, Pictou County, 3.3% of red spruce seedlings in a 200-ha plantation north of Mount Thom, Pictou County, and was found in a seed orchard at Debert, Colchester County. In Prince Edward Island, two young (1 m in height) larch trees were killed in a demonstration woodlot near Valleyfield, Kings County.

Table 15. Armillaria root rot in spruce and pine plantations in various areas of New Brunswick in 1986.

| | | DNRE Resource Management Region | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Number of plantations assessed | Spruce | 15 | 5 | 17 | 7 | 51 |
| | Pine | 10 | 6 | 16 | 7 | 5 |
| Percent of infected plantations | Spruce | 6 | 20 | 12 | 14 | 41 |
| | Pine | 22 | — | — | 14 | 25 |

Plots established in plantations to study the spread of the disease on different hosts and under different conditions have been assessed annually since 1983. The plantations are of different ages and were established in areas of somewhat different cover types. Subplots, comprised of the closest 10 trees around all infected trees have also been evaluated. The summary of observations is presented in Table 16. No changes occurred on the plots in 1986 but there was minor intensification by the disease on a few of the subplots. Trees in older plantations are said to acquire some resistance to fatal attack by Armillaria root rot, which they retain as long as they are in a vigorous stage without significant stress. Some of the study plantations are reaching this age, and all of them were free of weather or pest-related stress during the 1986 growing season. More plots of various species and especially of younger ages are to be established to assess the real significance of this disease in plantations.

Needle rusts were common throughout the Maritimes in 1986. *Chrysomyxa ledi* (dBy.) and *Chrysomyxa ledicola* Lagh. (alternate host for both: Labrador tea) were widespread on black spruce, white spruce, and red spruce but mostly at very low levels through much of the Region. The only exception was in a white spruce plantation at Goose River, Kings County, Prince Edward Island where 20% of the trees had 30% of the needles infected by *C. ledi*. The results of plantation surveys in New Brunswick showed that about 12% of spruce plantations assessed were affected by needle rust in 1986. Among the 21 infected plantations, 16 were white spruce, 2 black spruce, 1 Norway spruce, 1 hybrid spruce, and 1 a mixture of white and black spruce. All plantations from where samples were submitted were affected by *C. ledi*. The disease was found in two of the five DNRE regions and was most common in region 5 (31% of plantations assessed) and region 3 (29%). In infected plantations the rust was present on 60% of the trees but the level of infection was only a trace on 55%, light on 4%, and moderate on less than 1% (0.5%) of the affected trees. Moderate infection

Table 16. Armillaria root rot — spread of disease in plantations 1983–1986

| Species | Year Planted | Year plot Est. | Former Cover Type | Percent Mortality | | | | No. of subplots and percent mortality by year | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1983 | 1984 | 1985 | 1986 | 1983 | | 1984 | | 1985 | | 1986 | |
| | | | | | | | | No. | % | No. | % | No. | % | No. | % |
| Black Spruce | 1976 | 1983 | Softwood | 8 | 10 | 10 | 10 | 4 | 17 | 5 | 16 | 5 | 16 | 5 | 16 |
| Black Spruce | 1973 | 1983 | Softwood-Hardwood | 4 | 4 | 4 | 4 | 2 | 5 | 2 | 10 | 2 | 15 | 2 | 15 |
| Black Spruce | 1978 | 1983 | Softwood-Hardwood | 8 | 12 | 20 | 20 | 5 | 4 | 8 | 6 | 10 | 6 | 10 | 10 |
| Black Spruce | 1980 | 1983 | Hardwood-Sotfwood | 8 | 16 | 24 | 24 | 4 | 10 | 8 | 22 | 12 | 30 | 12 | 30 |
| Jack Pine | 1978 | 1984 | Softwood-Hardwood | — | 2 | 2 | 2 | — | — | 0 | — | 1 | 0 | 1 | 0 |
| Jack Pine | 1981 | 1984 | Softwood-Hardwood | — | 2 | 4 | 4 | — | — | 2 | 0 | 2 | 0 | 2 | 5 |
| Jack Pine | 1978 | 1984 | Softwood-Hardwood | — | 2 | 2 | 2 | — | — | 0 | — | 1 | 10 | 1 | 10 |
| Black Spruce | 1980 | 1985 | Softwood-Hardwood | — | — | 2 | 2 | — | — | — | — | 1 | 20 | 1 | 40 |

occurred in a hybrid spruce plantation at Marrtown, Kings County, on 8% of the trees and in a Norway spruce plantation at Dubee Settlement, Kings County, on 3% of the trees assessed.

In New Brunswick, *Coleosporium asterum* (Diet.) Syd. (alternate host: golden rod) and *Coleosporium viburni* Arth. (alternate host: *Viburnum* sp., wild raisin, hobblebush, highbush, cranberry, etc.) were the two species of needle rusts encountered on pine in 1986. While *C. viburni* appears mostly on jack pine, *C. asterum* affects both jack pine and red pine and the two species may occur together when the respective alternate hosts are present. Because field identification on jack pine is impossible and because numerous reports, especially from plantation surveys, are not supported by samples for laboratory identification, these rusts are discussed together.

*Coleosporium viburni* has been by far the most important needle rust encountered in the province in recent years. Repeated severe infection and the needle drop that follows resulted in young plantation trees being sustained only by their current foliage in a number of areas in the southern half of the province. Infection levels are closely correlated to the abundance of the alternate host and the distance of trees from it. Smaller trees are more seriously affected. In 1986, needle rust was still common but infection rates were lower than in previous years. The results of plantation surveys showed that more than half (52%) of the jack pine plantations assessed were affected by needle rust in New Brunswick in 1986. The disease was most common in DNRE region 3 in the southeastern part of the province where the rust was found in 83% of the plantations assessed. Needle rust was common in infected plantations as 58% of the trees assessed supported the fungus but the level of infection was only a trace on 42%, light on 7%, moderate on 8%, and severe on 1% of the affected trees (Table 17). Severe infection occurred in three plantations, all in the southeastern part of the province, but even in these no more than 12% of the trees assessed supported this level of infection.

In Nova Scotia, needle rusts were common on pine but generally little infection was observed. The highest infection occurred in a jack pine plantation southwest of Shulie, Cumberland County, where 54% of the older needles were affected.

In Prince Edward Island, a few scattered red pine plantations were affected but not more than 5% of the needles were infected. The most serious needle rust infection occurred in a 7-year old, 6.5-ha jack pine plantation at Goose River, Kings County, where 60% of the older needles turned yellow and all trees in the plantation suffered damage.

Research was initiated in response to the concern over the effect of needle rust on the condition of jack pine plantations in New Brunswick. Objectives are to determine the relationship between infection levels and volume increment reduction toward the establishment of threshold levels for control, and to determine the seasonal occurrence of various spore types with special reference to the time period when pine is infected, and control of the rust. Early results are expected during 1987 and will be disseminated when available.

The Seedling debarking weevil, *Hylobius congener* D.T., has been suspected as the causal agent in the mortality of newly planted coniferous seedlings in central Nova Scotia since the beginning of the 1980s. Its association with the problem was first reported in 1984, when seedling mortality exceeded 85% in some plantations. The insect is present on the sites as early as the time of harvest. Debarking of the stems of seedlings occurs from spring through to fall resulting in progressively increasing seedling mortality. The amount of damage is related to forest management practices, such as "hot planting," i.e., the reforesting of cutover areas very soon after harvest, site preparation, plantation size, and the proximity of plantations to other harvested areas. The level of concern for this insect is related to increased aware-

Table 17. Needle rust in infected jack pine plantations in New Brunswick.

| NBDNR&E Region | Number of plantations assessed | Percent of plantations affected | Percent of trees infected in plantations | Percent of trees in various infection categories | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Neg 0% | Trace 1–5% | Light 6–29% | Mod 30–70% | Severe 71–100% |
| 1 | 9 | 44 | 40 | 60 | 39 | 0.3 | 0.7 | 0 |
| 2 | 6 | 43 | 20 | 80 | 19 | 0.5 | 0.5 | 0 |
| 3 | 16 | 81 | 83 | 17 | 54 | 13 | 14 | 2 |
| 4 | 7 | 43 | 43 | 57 | 34 | 4 | 5 | 0 |
| 5 | 4 | 50 | 34 | 66 | 34 | 0 | 0 | 0 |
| N.B. | 42 | 52 | 58 | 42 | 42 | 7 | 8 | 1 |

ness by forest managers, to recognition that past unexplained plantation failures may have been the result of weevil damage, and the realization that in the absence of practical control methods the future of large-scale plantation programs may be jeopardized.

In 1986, a survey of about 130 areas by the Forest Insect and Disease Survey in cooperation with numerous government and industrial agencies showed that although the most serious damage occurred in eastern mainland Nova Scotia and eastern Prince Edward Island considerable damage also occurred elsewhere in the Region. Table 18 illustrates the percent of plantations by province in the various damage categories.

Research, initiated in 1985, continued in 1986 and dealt with determining the life cycle of the insect, as it relates to control, and factors that were indicated as important in the management of the problem, i.e., time elapsed between harvesting and replanting, techniques of site preparation, size of the area planted, silvicultural methods applied in surrounding areas. A variety of control tactics, such as insecticides, biological control, physical barriers, site preparation techniques, pheromones and other attractants, rescheduling planting dates, were also investigated. Analysis of research results is under way and the development of a hazard rating system and of a management model have been initiated. Some results are expected in advance of the next planting season and will be disseminated.

Mites are minute organisms, hardly visible to the naked eye. They cause damage by puncturing the surface of needles or young succulent shoots with their mouth parts and sucking out the sap. Affected foliage appears mottled or, when populations are high, reddish discoloration results. Seriously affected needles will fall prematurely. Some species of mites also produce a webbing which collects dust and debris giving affected trees a dirty, unhealthy appearance. High mite populations are often associated with dry, hot weather.

Spider mites, mainly the spruce spider mite, *Oligonychus ununguis* (Jacobi), on spruce and on pine, and a species of *Eurytetranychus* on spruce reached epidemic proportions in 1982 in both plantations and natural forests in southern and central New Brunswick. Although populations have declined, mite-infested coniferous areas have been observed in both New Brunswick and Nova Scotia each year since then.

In 1986, spider mites again caused various levels of discoloration in a few areas of New Brunswick and Nova Scotia, mainly on ornamental conifers.

A spider mite on larch, *Oligonychus laricis* Reeves, caused discoloration, ranging from trace to moderate, in a plantation of grafted stock at the Acadia Forest Experimental Station, Sunbury County, New Brunswick. This is the first record of this mite in the Maritimes Region.

Mites on pine, *Oligonychus milleri* (McGregor) and to a much lesser degree, *Setoptus jonesi* (Keifer), became a major concern in 1985 as a result of various degrees of discoloration observed in numerous jack pine plantations, especially in the southern half of New Brunswick. Many of the trees were off-color, the discoloration ranging to bronze to red. The condition varied from only 4% trace discoloration to 100% severe reddening, but on average, 31.5% of the shoots sustained heavy feeding, 10.8% moderate, 13.2% light, 14.7% trace feeding, and 29.8% were healthy.

In 1986, a regional survey for spider mites in red and jack pine plantations found that while *O. milleri* was the most frequently encountered species, a large group of other mites is also associated with these trees. The effect of most of these on the trees is uncertain. Foliage discoloration associated with mites was widespread, but did not exceed light, in New Brunswick. In Nova Scotia, severe and moderate discoloration occurred in patches, ranging in size from one to several hectares, on the Trafalgar burn area of Pictou and Guysborough counties, with dis-

Table 18. Frequency of plantations in five categories of seedling mortality caused by the seedling debarking weevil in the Maritime Provinces in 1986.[a]

| Seedling Mortality Range (%) | Percent of plantations in damage category | | |
|---|---|---|---|
| | New Brunswick | Nova Scotia | Prince Edward Island |
| None | 73 | 39 | 41 |
| 1 - 5 | 20 | 32 | 17 |
| 6 -10 | 7 | 14 | 0 |
| 11-20 | 0 | 11 | 17 |
| 21- | 0 | 4 | 25 |

[a] 17 negative plantations on Cape Breton Island, N.S., where research type assessments were conducted, have been omitted from the calculations.

coloration of lesser intensity at many places elsewhere in the province. In Prince Edward Island, spider mites were found at nine of ten plantations examined but discoloration was negligible. The only exception occurred in a 2 to 3-ha jack pine plantation at North Enmore, Prince County, where discoloration occurred in 1985, that was re-examined in 1986. Spider mite populations were still present although at levels lower than in 1985. Trees in the areas with severe discoloration last year either died or had some level of top mortality. Trees in the area of lesser damage last year showed a marked improvement in color from 1985, no top mortality occurred and none of these trees died.

Studies were initiated in 1986 to determine certain aspects of the life cycle in order to establish timing for control, and to devise a sampling technique to assess mite populations reliably in the field.

## Ontario

In 1987, special surveys focused on white pine plantations in southern Ontario and black spruce plantations in northern Ontario.

### White Pine Plantations

In this survey, 5700 trees were examined in 38 plantations. Two visits were made to each plantation to accommodate the feeding period of expected insect and disease pests. The results were as follows:

***Insects*** — The most abundant insect was the pine spittlebug *Aphrophora cribrata*, (Walker), which was recovered from 937 trees or 16% of the total. It was found in 24 of 38 plantations examined and was fairly evenly distributed throughout the area of the survey. Although the insects were quite numerous in some cases, no serious damage was reported. The pine bark adelgid, *Pineus strobi* (Htg.) was detected on 477 trees or 8% of the total. The insect was most abundant in the Eastern and Northeastern regions where it was recorded on 29% and 14%, respectively, of the trees examined. Low populations were detected in the Southwestern and Central regions and the insect was not recovered in the Algonquin Region. No serious damage was recorded. The white pine weevil, *Pissodes strobi* (Peck), is probably the most damaging insect recovered in the survey. It was found in 17 of the 38 plantations, infesting 150 of 5700 trees or 3% of the total examined. The insect was recorded in all five regions with incidence ranging from $<1$ to 4%. Other insects encountered during the survey but which did not cause appreciable damage included the eastern pine shoot borer, *Eucosma gloriola*, Heinr.; the fir coneworm, *Dioryctria abietivorella* (Grt.); the pine false webworm, *Acantholyda erythrocephala* (Linn.); the introduced pine sawfly, *Diprion similis* (Htg.); the northern pine weevil, *Pissodes approximatus* Hopk.; and aphids of various species. Feeding damage by porcupines was recorded in four plantations and by sapsuckers in two plantations.

***Diseases*** — Very little damage caused by diseases or abiotic conditions was encountered during the survey. Foliage damage as a result of frost, winter drying, or in a few cases, needle cast was recorded in 320 trees or 6% of the total. White pine blister rust, *Cronartium ribicola* J.C. Fischer, one of the most serious diseases of white pine was recorded on 76 trees — 1.3% of the total. Armillaria root rot, *Armillaria mellea* (Vahl:Fr.) Kummer and stem cankers of unknown origin were each recorded on less than one percent of the trees.

### Black Spruce Plantations

Plantation surveys in northern Ontario focused on black spruce in 1987. In 42 plantations in the Northern, Northwestern, and North Central regions, 6300 trees were examined with the following results:

***Insects*** — The most commonly encountered insect was the spruce budworm, *Choristoneura fumiferana* (Clem.), which was found on 1435 trees or 23% of the total. The insect was found in 24 of the 42 plantations or 57% of the total, most of which were in the North Central and Northwestern regions. The white pine weevil, *Pissodes strobi* (Peck), was the second most abundant insect, but was found on only 38 of the 6300 trees — 1% of the total. It was found in 11 of the 42 plantations, all of which were in the Northwestern and North Central regions. The yellowheaded spruce sawfly, *Pikonema alaskensis* (Roh.), was collected from one tree and the spruce coneworm, *Dioryctria reniculelloides* Mut. & Mun., was collected from four trees. Other insects encountered during the survey included the blackheaded budworm, *Acleris variana* (Fern.); the spruce bud midge, *Rhabdophaga swainei* Felt.; the greenheaded spruce sawfly, *Pikonema dimockii* (Cress.); the ragged spruce gall adelgid, *Pineus similis* (Gill.); and various species of aphids, none of which caused any appreciable damage.

***Diseases*** — The most abundant diseases were the spruce needle rusts, *Chrysomyxa ledi* (Alb. & Schwein.) de Bary and *C. ledicola* (Peck) Lagh. which were found in 1790 trees or 28% of the total. The highest number of infected trees (61%) were in the North Central Region followed by the Northwestern Region (36%) and the Northern Region (1%). Frost damage was recorded on 1719 trees, 27% of the total examined in all three regions, however, the damage was more prevalent in the North Central Region. The only other disease recorded was Armillaria root rot which was found on eight trees, most of which were in the North Central Region.

## British Columbia

Black army cutworm, *Actebia fennica* (Tausch.), caused mortality, bud damage, and severe defoliation of conifer seedlings and herbaceous ground cover

in recently burned and planted sites in the Prince Rupert, Prince George, and Cariboo regions, some for the fifth consecutive year. Some planting schedules were delayed. About 6000 white spruce and some lodgepole pine were killed in parts of 10 recently planted sites in the Prince Rupert Region. Up to 10 000 lodgepole pine seedlings and most ground cover were severely defoliated at two sites in the Prince George Region. Larvae were common in the Cariboo Region for the third consecutive year but damage to Douglas-fir and lodgepole pine seedlings at five sites and ground cover at 11 other sites was minimal.

Trap data and numbers of pupae in the duff layer indicate continuing cutworm populations with the potential for damage to conifer seedlings in 1987 spring planting areas in the Prince Rupert and Prince George regions. Based on historical patterns, a similar potential exists in the Cariboo and Kamloops regions where the number of slash burns in susceptible areas increased significantly in 1986. Small numbers of Tachinid flies and Ichneumonid and Braconid wasps parasitized some larvae in some areas, but there was no evidence of nuclear polyhedrosis virus.

Numerous other insects and disease problems occurred, but only selected observations made in 1986 are reported. Many of these pests are common, widespread and perennial.

Pathogens occurred at varying levels in mature lodgepole pine adjacent to recently planted Scots pine and selected lodgepole pine from Sweden at four sites in the Prince George Region and one near Whitehorse. These included lodgepole pine dwarf mistletoe, *Arceuthobium americanum* Nutt. ex Engelm., near Fort St. James and Mackenzie, and western gall rust, *Endocronartium harknessii* (J.P. Moore) Y. Hirat., at Fort St. James, Mackenzie, Fort St. John, Fort Nelson, and Whitehorse.

Numerous patches of bark chewed by porcupine, *Erithizon d. nigrescens* Allen, from the stems and branches of conifers in 41 young stands in the western part of the Prince Rupert Region are expected to result in widespread tree mortality, particularly in 31 spaced stands along the west Kalum Road. Half the trees were lodgepole pine, the remainder were equal numbers of western hemlock, amabilis fir, and Sitka spruce. European larch in three plantations were severely debarked.

One-year old white pine needles on young trees in a long-term study plot near New Denver in the Nelson Region were lightly infected by *Scirrhia pini* Funk & Parker, less severely than in 1985. About 70% of the needles have been cast prematurely as a result of consecutive years of infections by red band disease.

Less than 5% of the year-old needles on 10% of the lodgepole pine seed orchard trees were infected by needle cast, *Lophodermella concolor* (Dearn.) Darker, at Red Rock south of Prince George. This was the lowest incidence of infection in 3 years. Small pockets of regeneration lodgepole pine near Summit Lake on the Alaska Highway were killed by severe infection of an unidentified needle disease. Needles in the upper third of the crowns of surviving pines were less severely infected but cast prematurely.

Post harvesting losses of planted stock to root diseases, particularly to Armillaria root disease, *Armillaria obscura* (Pers.) Herink, in southern interior forests and increasingly to tomentosus root disease, *Inonotus tomentosus* (Fr.) Gilbn., in northern interior forests, are of increasing economic importance.

## Stillwell's Syndrome (Sudden death of balsam fir trees)

Balsam fir trees, usually with a fair complement of foliage despite having been exposed to varying amounts of defoliation by the spruce budworm for several years, turn bright red and die. This phenomenon of "dropping out" of surviving balsam fir trees in spruce budworm-damaged stands during the apparent recovery stage, even years after the collapse of the outbreak, was noted by the late M.A. Stillwell during his pathological studies in the Green River Watershed of New Brunswick. In his honor, this phenomenon was named Stillwell's Syndrome in 1982 when the Forest Insect and Disease Survey first drew attention to this condition, discussing it in a section in its annual report.

Balsam fir trees stressed by repeated spruce budworm defoliation are susceptible to attack by numerous organisms normally considered to be secondary in nature. Investigations in 1982 into the possible cause of Stillwell's Syndrome found that all red trees sampled were affected by Armillaria root rot, *Armillaria mellea* (Vahl ex Fr.) Kummer, and at least one species of beetle. Balsam bark weevil, *Pissodes dubius* Rand., was present in 75% of the affected trees, balsam fir bark beetle, *Pityokteines sparsus* (Lec.), in 17%, and sawyer beetle, *Monochamus* sp. in 17%. However, observations elsewhere indicate that not all trees killed by Stillwell's Syndrome are affected by Armillaria root rot. Balsam bark weevil and balsam fir bark beetle frequently occur together on the same tree and sawyer beetle attack of weakened living trees is not uncommon.

Sudden death of balsam fir trees was reported in 1980 and 1981, from various parts of New Brunswick. In 1982, an unusually high number of balsam fir trees died in this manner and some areas of Nova Scotia were affected. The condition was present, but much reduced in 1983, and increased again in 1984 and

continued in 1985, especially in the northwestern part of New Brunswick.

In 1986, the problem further intensified in New Brunswick and literally thousands of balsam fir trees with bright red foliage were observed during early summer aerial surveys. The condition in the most affected areas of the western part of the province progressed to the point that small groups of trees rather than individuals were dying. Current tree mortality was in excess of 15% in about a quarter of the stands in New Brunswick and reached as high as 28% in one area in Restigouche County. As in previous years, the balsam fir bark weevil, *Pissodes dubius* Rand., was the most prevalent secondary insect found associated with the condition. In some areas spruce trees also appeared to be affected, but because of rapid needle loss and the lack of pronounced change in foliage color on this species, the "sudden death" is not as conspicuous.

Accumulating losses prompted some companies to change forest management plans and to alter cutting programs in order to conduct salvage operations in some of the most seriously affected areas. In Nova Scotia, recently dead balsam fir trees with bright red foliage were observed in the central part of the province, particularly in Colchester and Cumberland counties and in Victoria County on Cape Breton Island. These trees were widely scattered and often only one or a few trees were affected in any given area. Secondary insects and/or Armillaria root rot were always found associated with the condition.

In Prince Edward Island, only two trees, near Brookvale, Queens County, were classified as having died of the Stillwell's Syndrome.

## Pinewood Nematode

The pinewood nematode, *Bursaphelenchus xylophilus* (Steiner and Buhrer) Nickle, causes pine wilt disease and has been a serious disease in Japan since it was first discovered in 1905. The disease was first detected in the United States in 1979 but was recognized to have occurred much earlier. It now occurs in most of the continental states. However, the disease appears to be endemic or nonepidemic in North America.

An intensive survey for the pinewood nematode was conducted across Canada during the 1985 and 1986 field seasons by the Forest Insect and Disease Survey of the Canadian Forestry Service. A uniform sampling procedure (available on request) was used country-wide. In 1986, initial extractions and identification of the nematodes were carried out by most FIDS regional units. Some confirmations and final identification of the nematodes obtained, were made by Dr. Roger Anderson of the Biosystematics Research Institute, Ottawa. The survey is coordinated with Plant Health, Agriculture Canada, which is conducting surveys on wood chip piles in Canada.

The pinewood nematode survey and vector surveys are being conducted by CFS-FIDS as part of its Plant Quarantine related activities and the need for phytosanitary certification on exports of Canadian softwood chips. The survey in an extensive ongoing program and the locations sampled in 1986 covered Canada extensively (Figure 16).

Two forms of *Bursaphelenchus* have been identified:

1) The "R" form (*B. xylophilus*) found only on *Pinus* spp., including western white, lodgepole, ponderosa, scots, jack, red, and eastern white pines. Its distribution appears to be limited to certain areas of Canada, as indicated by distribution map (Figure 17).

2) The "M" form occurs across Canada commonly on spruce and balsam fir. The "M" form has been tentatively identified by Europeans as *B. mucronatus*. In Canada, it is associated most commonly with balsam fir which is declining for other pathogenic reasons such as root rot, dwarf mistletoe and spruce budworm defoliation. It has not been found on Scots pine. The "M" form of *Bursaphelenchus* does not appear to be pathogenic on pines or balsam fir.

### Newfoundland

The Forest Insect and Disease Survey in cooperation with Memorial University conducted the field work collecting wood borings and discs for evidence of this pest in the province. The pinewood nematode has not been found in Newfoundland.

### Maritime Provinces

In the Maritimes, the pinewood nematode has been a special concern of the Forest Insect and Disease Survey since 1980. Through general observations, forest condition assessment surveys, plantation surveys, pest extension activities, provincial cooperative surveys, and special surveys, FIDS staff have been on the lookout for symptomatic suspect trees. In the 5 years from 1980 to 1984, 15 such trees were located. These included red pine, Scots pine, white spruce, and balsam fir. Nematodes were extracted from some of these and submitted for identification. Reports indicate that none of the samples submitted were of the pinewood nematode. In 1984, suspect nematodes were extracted from two samples (one a balsam fir, one a white spruce). One sample contained two species of nematodes, a bacterial feeder and a mycophagous species (fungus eater). The nematode from the other sample was identified as "definitely not pinewood nematode." Also in 1984, a number of bark beetles from stressed balsam fir

**Figure 16.** Locations across Canada sampled in 1986 for pinewood nematode.

**Figure 17.** Locations where the "r" form of the pinewood nematode was found in Canada in 1986.

were tested as possible vectors for the pinewood nematode — with negative results.

In the fall of 1985 and the summer of 1986, a special survey was conducted as part of a national effort to establish the presence and distribution of the pinewood nematode in Canada. Recently dead, old dead, and a few living trees were sampled, and from a number of locations, insects, considered possible vectors for the nematode, were also analyzed. In total, samples were obtained from 185 locations; 119 in New Brunswick, 55 in Nova Scotia and 11 in Prince Edward Island. The various host-samples are shown in Table 19.

Although the objective was to obtain a good species mix in sampling, balsam fir received special attention, especially in the early part of the survey, because of the similarity in symptom expression between Stillwell's Syndrome and the supposedly sudden wilting of conifers when killed by the pinewood nematode. No pinewood nematode has been identified from any of the balsam fir trees that succumbed to the Stillwell's Syndrome.

Pinewood nematode, the "R"-form of *B. xylophilus*, has been identified at three locations in New Brunswick. In each case only one tree at the site was positive and none of the trees was considered to contain high enough populations of pinewood nematode to have been the direct cause of tree death. Pinewood nematode was found in a recently dead jack pine tree at Nevers Brook, Kent County, in a wind-thrown, recently dead jack pine tree in the Hebron Mountain area, Kings County, and in a recently dead white pine tree at Pleasant Mountain, Albert County.

Another *Bursaphelenchus*, the "M" form, has been identified at three other locations, one in New Brunswick and two in Nova Scotia. Again, in each case only one tree at the site was positive and the nematode was present in very low numbers, not high enough to have killed the trees. The "M" form was found in a recently dead balsam fir at Sisson Branch,

Table 19. Summary of Pinewood Nematode Surveys in the Maritimes Region in 1985 — 1986.

| Sampling Variables | Number of samples | | | |
|---|---|---|---|---|
| | Maritimes Region | New Brunswick | Nova Scotia | Prince Edward Island |
| Locations Sampled | 185 | 119 | 55 | 11 |
| Tree Species Sampled | | | | |
| Balsam fir | 157 | 87 | 58 | 12 |
| Jack pine | 40 | 40 | — | — |
| Red pine | 13 | 6 | 6 | 1 |
| Scots pine | 18 | 12 | 5 | 1 |
| White pine (eastern) | 41 | 18 | 19 | 4 |
| Black spruce | 49 | 17 | 29 | 3 |
| Red spruce | 16 | 8 | 8 | — |
| White spruce | 22 | 13 | 6 | 3 |
| Total trees sampled | 356 | 201 | 131 | 24 |
| Insects Sampled | | | | |
| Sawyer beetle (*Monochamus* sp.) | 15 | 14 | 1 | — |
| Seedling debarking weevil (*Hylobius* sp.) | 23 | 7 | 16 | — |
| Total insects sampled | 38 | 21 | 17 | — |
| Total samples (trees and insects) | 394 | 222 | 148 | 24 |

Victoria County, New Brunswick; in a recently dead balsam fir at Devon, Halifax County, Nova Scotia; and in a recently dead black spruce on the Stanley Management Unit, Hants County, Nova Scotia.

There is, to date, no evidence to justify the classification of the pinewood nematode in the Maritimes as an organism of biological importance (i.e. a tree killer) but the consequences of its presence may be economically significant if it affects the export some forest products, such as wood chips, because of plant quarantine related regulations in other countries.

## Quebec

In 1985, only dying or recently dead trees were sampled, regardless of the cause of mortality, and the survey covered primarily the area from the Quebec City Region to the Gaspé/Lower St. Lawrence Region and focused mainly on balsam fir.

Examination of the nematodes obtained during this survey, by taxonomists with Agriculture Canada's Biosystematic Research Centre in Ottawa, revealed the presence of the mucronate form (the "m" form) of *B. xylophilus* in 21 sampling sites on fir and one site on white pine (Figure 18).

In 1986 the survey was extended to cover the entire province, concentrating on the sampling of pines. Samples were taken of 58 white pines, 60 jack pines, 57 red pines, and 42 Scots pines, as well as one white spruce and 9 balsam firs.

In all, 227 trees from 123 sites were sampled and nematodes (not identified yet) were extracted from the wood of 79.7% of these trees. Saprophyte nematodes are known to be common in the wood of dying trees. At this time, identification results have been received for only four Scots pine stems which all came from the same pile of wood south of La Pocatière (Kamouraska). Three of these logs contained an appreciable number of pinewood nematodes in the typical "r" form. The fourth log contained other species of nematode of the genus *Bursaphelenchus*.

Results of identification are awaited for the other 177 samples, which are presently in Ottawa. Figure 16 summarizes the situation as it is now in Quebec.

## Ontario

The pinewood nematode was discovered in Ontario in 1984 when the organism was positively identified from three locations in southern Ontario. Intensive surveys were carried out in 1985 and 1986 to determine the distribution of this pest in the province. As a result, about 448 samples were examined in the 2 years. Of these, 30 samples have been confirmed as the "R" form of *B. xylophilus* whereas an additional 13 samples have been confirmed as the "M" form of the organism.

Most of the "R" form collections were made from jack pine, red pine, and white pine with a few from Scots pine and one from white spruce. In contrast, most of the "M" form collections were from balsam fir along with a few collections from red pine and jack pine. A large number of samples (approximately 207) which contain nematodes are still being processed to determine which species and form of nematodes are present. It is apparent, however, that the pinewood nematode is present throughout Ontario as shown by Figures 17 and 18 which show the distribution to date of both forms of the organism.

## Prairie Provinces

In 1985, FIDS collected jack pine and balsam fir wood samples from southeastern Manitoba, and lodgepole pine from southwestern Alberta; all were negative for the pinewood nematode. In the spring of 1986, an extensive survey was launched in the three prairie provinces to determine the presence of the nematode, its distribution, and its preferred hosts. Samples of recently dead and dying trees were collected from each of 49 locations, representing up to five different conifer species at each site. To date, about 90% of the wood samples have been processed for nematode extraction. Of these, 92 vials containing nematodes were submitted to Agriculture Canada's Biosystematics Unit in Ottawa for identification.

To date, the pinewood nematode, *Bursaphelenchus xylophilus* has been found at the following locations:

| | Host Tree | Location |
|---|---|---|
| *Bursaphelenchus* 'R' form | Jack pine | Smoky Lake, Alberta |
| 'R' form | Jack pine | Clearwater, Manitoba |
| 'R' form | Lodgepole pine | Cypress Hills, Alberta |
| (1983) 'R' form (presumed) | Jack pine | Belair, Manitoba |
| (1984) 'R' form (presumed) | Jack pine | Belair, Manitoba |
| (1985) 'R' form (presumed) | Wood chips (tP, wS, bS) | Prince Albert, Sask. |
| *Bursaphelenchus* 'M' form | Balsam fir | Whitecourt, Alberta |
| 'M' form | White spruce | Candle Lake, Sask. |
| 'M' form | Balsam fir | Lac La Biche, Alberta |

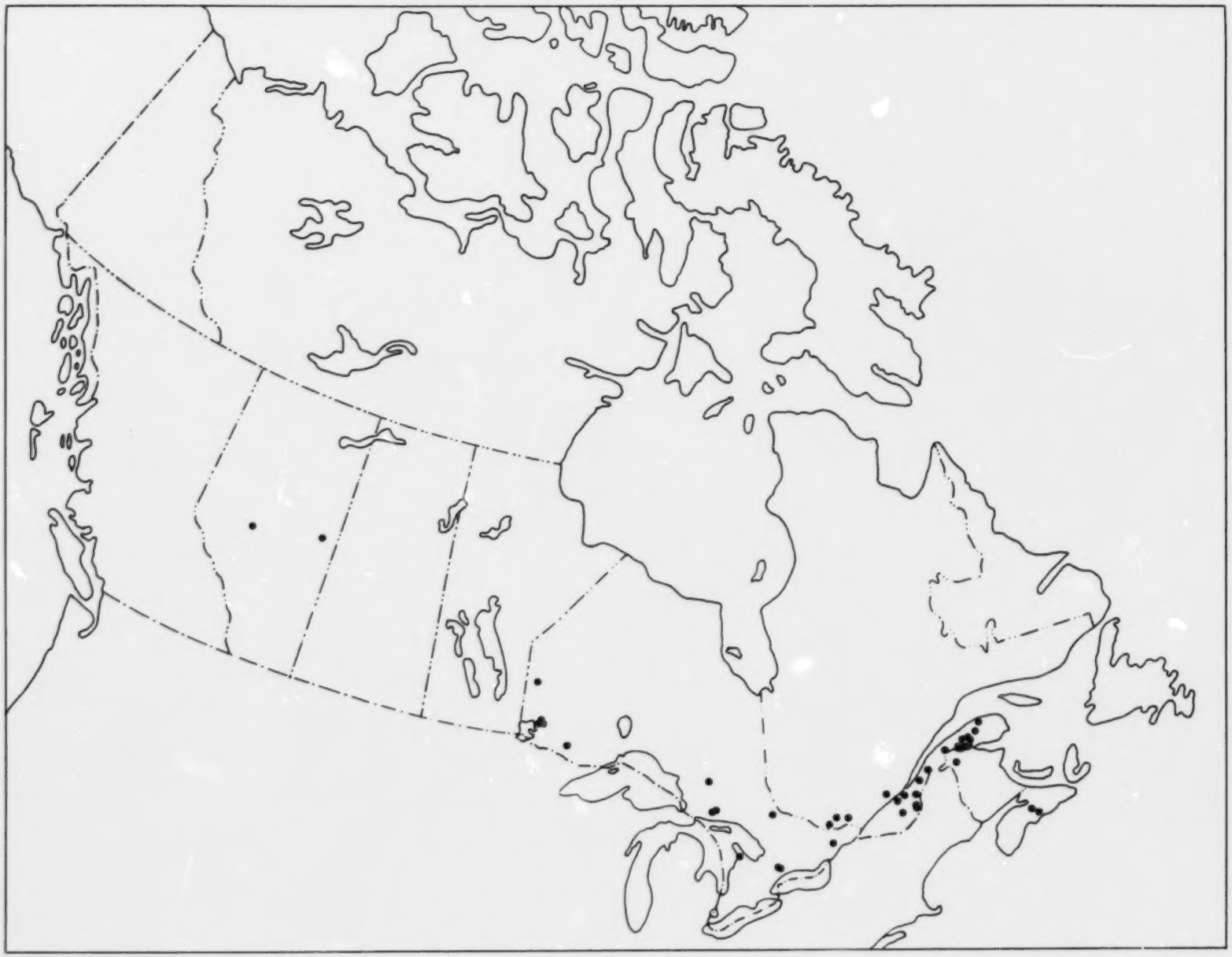

**Figure 18.** Locations where the "m" form of the pinewood nematode was found in Canada in 1986.

In addition, four white spruce seedling samples from the provincial tree nursery at Smoky Lake, Alberta were extracted for nematodes and all were negative for *Bursaphelenchus*.

### British Columbia

Examination of branch and stem samples from 203 symptomatic dying conifers indicates that pinewood nematode has been isolated from two species of pine at two widely separated locations for the first time in British Columbia. Wood chips collected by Agriculture Canada, Plant Health at five interior mills mainly in the Cariboo Region also contained pinewood nematodes. Damage to the forest is not widespread as in Japan, but rather individual trees usually stressed by fire, road construction, or earlier attacks by bark beetles were found to contain relatively small numbers of the pinewood nematode. Positive collections were very widely distributed in lodgepole pine near Houston in northwestern British Columbia and in ponderosa pine near Cranbrook.

Native bacterial or insect-associated nematodes including *Aphelenchoides* sp., *Cryptaphelenchus* sp., *Deladenus* sp., and *Acrobeles* sp. were isolated from 32 of the samples from lodgepole, western white, whitebark and ponderosa pines, and from four adult woodborers.

## Other

### Quebec

**Balsam fir survey**

During the summer of 1986, many balsam fir trees with red foliage were observed, either isolated or more or less grouped in a number of stands located primarily in the Laurentides Reserve and the Gaspé/Lower St. Lawrence Region. The most likely causes of this condition were Armillaria root rot, a fungus, and bark-boring or xylophagous insects. Using data supplied by the Insect and Disease Protection Service of the Quebec Department of Energy and Resources, FIDS personnel visited 50 stands where a significant number of red fir trees had been seen.

In each stand, an estimate was made of the percentage of reddish balsam firs, based on the location in the stand where the incidence of red foliage seemed highest. In addition, 5 to 10 of the affected trees, selected from the codominant and dominant sections of each stand, were examined more closely. The diameter and height of each of these trees were measured and the base of each tree was examined by partially lifting the bark, first along a 1.5-m length of the trunk to detect the presence of insect galleries, then at the stump and, if possible, over a 1-m length of each of the 2 to 4 major roots to detect Armillaria root rot fungus.

Between 5 and 10 trees, reddened and nonreddened respectively, were sampled in 20 of the 50 stands visited with a Pressler borer to determine their relative growth rates. Growth measurements were made in the laboratory using a binocular microscope.

A total of 314 balsam firs was examined in this study. The percentage of reddish trees varied from less than 1% to 10% of the firs present when only the few most affected areas of the stands were considered. But by increasing the sampling area of each stand, all assessed percentages fell to below 1%. The 314 trees, representing an average of 6.2 trees per stand, had an average diameter of 17.9 cm and height of 12.6 m. Insect galleries were observed on 305 trees and 9 trees had no insect galleries in the lower part of their trunk, below 1.5 m from the ground. Probably, these trees were being attacked by other insects higher on the trunk. Galleries of the following insect species were most often identified:

— white spotted sawyer, *Monochamus scutellatus* (Say), on 72% of firs examined;

— balsam fir bark bettle, *Pityokteines sparsus* (Lec.), on 54.8% of firs examined;

— striped ambrosia beetle, *Trypodendron lineatum* (Oliv.), on 48.1% of firs examined;

— balsam bark weevil, *Pissodes dubius* Rand., on 9.9% of firs examined;

The percentages do not add up to a total of 100 because several trees had galleries of 2 or 3 species, and some even had all 4 species.

Armillaria root rot, *Armillaria mellea* (Fr.) Kummer, was observed on 215 firs, or 68.5% of trees examined. Among these trees infested with root rot, 72.9% of the 723 roots examined carried at least traces of infection (mycelium present) by *Armillaria mellea* on another root rot. The remaining 99 trees had apparently healthy root systems; 327 roots were examined on these trees but no trace infection was found.

The insects reported here are known to attack trees that are already under stress. In this case, the link between the presence of severe stress and repeated defoliations caused by spruce budworm seems clear. In the 50 stands visited, although only 10 showed evidence of probable moderate or heavier defoliation in 1986, 43 seemed to have suffered moderate or heavier defoliation in recent years based on the quantity of foliage remaining on the trees. Growth ring analysis of 79 reddened fir trees in these stands confirms the probable presence of heavy stress. These trees, with a mean diameter and age of 17.8 cm and 56 years respectively, suffered a 57.4% reduction in their mean annual growth rate

between 1981 and 1985 (0.46 cm/year), in comparison with the rate from 1971 to 1980 (1.08 cm/year).

To determine whether the stress suffered by reddened trees had been heavier than that suffered by still-green trees growing in the same environment, growth measurements were made on 34 balsam firs and 14 white spruce trees located near the affected firs but not reddened. Equivalent growth rate reductions were only 35.6% and 30.7%, respectively, for green trees whereas the trees infested by secondary insects and subsequently, reddened, suffered a 57.4% reduction in growth from 1981 to 1985, as reported above. These results indicate a tangible difference in the impact of defoliation on still-green trees as compared to reddened trees.

The occurrence of reddened fir trees, as observed frequently in 1986, can readily be explained. First, they are highly visible because neighboring fir and spruce trees, which survived the spruce budworm infestation, suffered little defoliation this year and retained their green foliage. The reddened trees died rapidly as the result of a severe infestation by one or more bark-boring or xylophagous insects. The insects mentioned previously in this report typically attack trees that are already under stress, and the growth ring studies reported here indicate that these reddened trees suffered a greater impact from budworm defoliations in 1981 to 1985 than did the neighboring trees which are still green. Finally, Armillaria root rot, although present, does not appear to be a significant cause of the problem.

To monitor the evolution of this situation, FIDS–LFC has established three permanent study plots in stands where 50 green fir trees are located near several reddened fir trees. Trees have been located and marked, and their health condition noted. These plots will be reviewed annually over the next 2 or 3 years.

**Bruce Spanworm**
***Operophtera bruceata* (Hulst)**

Bruce spanworm populations continued to decline on the south shore of the St. Lawrence between the Saint François and Chaudière rivers. The effect of the insect was considered negligible in all areas where it was still active in 1985, including Saint Augustin de Woburn and Piopolis.

In western Quebec, the Bruce spanworm continued to be highly active. Damage caused by this insect was found primarily within a large triangular area between the localities of Montebello, Fort Coulonge and Ferme Neuve. Aerial and field surveys of defoliation made it possible to determine the scope of infestation; about 87 100 ha were infested, 83% at moderate or severe levels.

The sugar maple, the primary species affected by this insect, suffered severe defoliation mainly in areas south of Notre Dame du Laus, south of Notre Dame de Pontmain, and northeast of Fort Coulonge, near the localities of Lauréat and Omer. Moderate defoliations were found particularly around lakes Simon and La Blanche, between the Petite Rivière Rouge and Du Lièvre rivers. Moderate defoliation sites were also noted near Mont Laurier along the Du Lièvre River, and northeast of Fort Coulonge in the same area as previously. Southeast of the Baskatong Reservoir, a few maple stands also suffered moderate defolation.

A survey of adult female Bruce spanworms was carried out in autumn on 29 sites scattered primarily throughout stands where significant Bruce spanworm damage had been reported. The results of this survey indicate that there will likely be an overall decline, throughout the 1986 affected area, in the Bruce spanworm population in 1987.

**Swaine Jack Pine Sawfly**
***Neodiprion swainei* Midd.**

The Swaine jack pine sawfly was found in the jack pine forests of Quebec more frequently this year than in previous years. Although populations of this insect continue to remain at an endemic level in most susceptible stands, a population increase was noted in several areas of the Saguenay/Lake Saint Jean, Trois Rivières, and Montreal regions. One hundred and thirty-seven surveys were conducted in natural forests in these regions, and the insect was found in 40 locations. Trace and light damage was recorded in 80% of these locations. An aerial survey was also conducted for the fifth consecutive year in the most susceptible jack pine forests, located in the Saguenay/Lake Saint Jean and Trois Rivières regions. This survey was conducted by helicopter and covered about 4 000 km$^2$. The results shown in Table 20 indicate that damage caused by the insect is generally not extensive, but Swaine jack pine sawfly populations are increasing in certain infested areas.

In the Saguenay/Lake Saint Jean Region, infested areas were found primarily southwest of Roberval, in the La Lièvre ZEC, where an epidemic had been uncovered in the early 1980s and a control program carried out in 1985. Moderate-to-severe damage was recorded over small areas near lakes Rodez, Henri, de l'Ouest, aux Iroquois, Panache, and Philippe. Although damage was light, the insect was also found more frequently north of Lake Saint Jean, from the locality of Normandin to a point north of Mistassini. In the Trois Rivières Region, the presence of this sawfly intensified in the southeastern part of the Gouin (43) management unit, and in the northwestern part of the Lower Saint Maurice (41) management unit. The damage observed was light, however, throughout the areas surveyed.

In the Montreal Region, Swaine jack pine sawfly populations were found near the Taureau Reservoir.

Table 20. Swaine jack pine sawfly infested areas in Quebec — 1986 aerial survey

| Administrative region | Sectors | Levels of defoliation | | | |
|---|---|---|---|---|---|
| | | Light (ha) | Moderate (ha) | Severe (ha) | Total (ha) |
| Saguenay-Lake Saint Jean (02) | ZEC La Lièvre | 1 770 | 200 | 44 | 2 014 |
| Trois Rivières (04) | Lac Decoste | 2 500 | — | — | 2 500 |
| | Lac Cousacouta | — | — | — | — |
| | Lac Gagnon | — | — | — | — |
| | Lac Dupuis | — | — | 75 | 75 |
| Total | Province | 4 270 | 200 | 119 | 4 589 |

One infested area near Lake Charland was of particular interest; first reported in 1984, the damage caused by this infestation has intensified steadily. The insect has caused damage over an area of approximately 200 ha around an epicentre of some 3 ha which was severely infested. The severity of damage decreases gradually away from this epicentre. In the Outaouais Region, the presence of the insect was significant only in two localities north of the Cabonga Reservoir, and light damage was reported.

***Control*** — Evaluation of the *Borrelinavirus swainei* Smirnoff virus experimental spray program conducted in 1985 south of Roberval (La Lièvre ZEC) continued in 1986. The purpose of this project, conducted by the Quebec Department of Energy and Resources in cooperation with the Canadian Forestry Service, was to assess the effectiveness of the virus, prevent the multiplication and propagation of the Swaine jack pine sawfly over the infested area and, finally, to reconstitute a viral preparation stock in order to pursue biological control development work. Results of the microscopic analyses conducted by the Canadian Forestry Service in 1985 showed that 62% of the larvae were affected by the virus in plots treated with a concentration of 5 × 10 polyhedrons per mL, and that this percentage reached 53% in areas treated with 3.3 × 10 polyhedrons per mL. Quebec Department of Energy and Resources evaluations also showed that 65% of the 540 Swaine jack pine sawfly colonies examined in the forest showed signs of viral infection, but that no larval mortality had occurred. Microscopic analyses conducted in 1986 showed that 35% of the larvae were affected by the virus in treated areas.

The health of larvae was also evaluated in the field: 176 larvae colonies were isolated in bags attached to the branches of the host species to keep the colonies captive while allowing them to feed normally. This apparatus was installed immediately upon the emergence of larvae, which were also examined at the end of the development of their larval cycle. The virus was found to be present in 14% of the colonies, but no larval mortality was recorded. In comparison with 1985, insect populations increased in both treated and control areas in 1986. Populations estimated in 1985 at 6.1 and 3.7 colonies per tree in areas treated with 5 × 10 and 3.3 × 10 polyhedrons per mL totalled 14.0 and 15.3 colonies per tree in 1986. In control areas, average populations were 12.9 colonies per tree in 1986, as compared to 5.6 colonies per tree in 1985.

Preliminary test results have not demonstrated the effectiveness of viral suspensions in preventing Swaine jack pine sawfly population growth during periods of resurgence. The viral concentration sprayed and the weather conditions may be among the factors responsible for the ineffectiveness of the virus.

# Other Insects, Diseases, and Damage

## Newfoundland Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Alber leaf beetle *Chrysomela mainensis mainensis* Bech. | Alder | Western Newfoundland | Low populations and light defoliation. |
| Alder leaf miner *Fenusa dohrnii* Tischb. | Alder | Western and eastern Newfoundland, eastern Labrador | Low to moderate populations. Browning ranged from light to severe. |
| Anthracnose *Kabatiella apocrypta* (Ell. & Ev.) Arx | Red maple | Western Newfoundland | Low incidence; 10% of foliage on some trees affected. |
| Balsam fir sawfly *Neodiprion abietis* complex | Balsam fir<br>White spruce | Western, central and eastern Newfoundland | Low populations and no significant defoliation. |
| Balsam twig aphid *Mindarus abietinus* Koch. | Balsam fir | Western and eastern Newfoundland | Populations ranged from low to high. Moderate infestations recorded at two locations on the Avalon Peninsula. |
| Balsam woolly aphid *Adelges piceae* (Ratz.) | Balsam fir | Western and central Newfoundland | Increased aphid damage to many young balsam fir stands particularly in Western Newfoundland. |
| Birch casebearer *Coleophora serratella* (L.) | White birch<br>Speckled alder | Western and eastern Newfoundland | Low to high numbers. Defoliation ranged from a trace to severe. |
| Birch leafminer *Fenusa pusilla* (Lep.) | White birch | Eastern Newfoundland, eastern Labrador | Low to high numbers. Trace to moderate browning. |
| Black knot *Apiosporina morbosa* (Schw.) Arx | Pin cherry | Avalon Peninsula | Low incidence near St. John's. |
| Blister rust *Cronartium ribicola* J.C. Fischer | Eastern white pine | Throughout Newfoundland | High incidence; up to 50% of naturally occurring white pine affected in most areas. |
| Broom rust *Melampsorella caryophyllacearum* Schroet. | Balsam fir | Throughout Newfoundland | Low incidence; up to 10% of the trees affected in some areas. Some trees had two brooms. |
| Cytospora canker and dieback *Cytospora* species | Red maple<br>Silver maple<br>Sugar maple<br>Sycamore maple<br>American mountain-ash | Avalon Peninsula | Moderate incidence; up to 30% of the branches were affected. Apparently trees were stressed due to climatic and soil conditions. |
| Diplcdia blight *Diplodia pinea* (Desm.) Kickx | Scots pine | Eastern Newfoundland | Moderate incidence; 10% of the trees affected in a Scots pine plantation. |
| Eastern blackheaded budworm *Acleris variana* (Fern.) | Balsam fir<br>Black spruce<br>White spruce<br>Engelmann spruce<br>*Larix kaempferi* | Throughout Newfoundland; eastern Labrador | Low populations. No significant defoliation. |

## Newfoundland Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Eastern dwarf mistletoe *Arceuthobium pusillum* Pk. | Black spruce | Eastern Newfoundland | There was an overall increase in mistletoe of 60% in plots established to monitor its spread. Up to 5 brooms were visible on newly parasitized trees and up to 7 brooms visible on older parasitized trees. |
| Eastern spruce gall aphid *Adelges abietis* (L.) | Black spruce<br>Sitka spruce<br>Engelmann spruce | Western and central Newfoundland | High numbers and 10% damage to Sitka spruce seedlings in Pasadena nursery. |
| European spruce sawfly *Gilpinia hercyniae* (Htg.) | Black spruce<br>White spruce<br>Sitka spruce<br>Engelmann spruce<br>Balsam fir | Western and eastern Newfoundland; eastern Labrador | Low populations. No significant damage. |
| Fall webworm *Hyphantria cunea* (Drury) | Speckled alder | Western Newfoundland | One nest only observed, with light defoliation. |
| Four-eyed spruce bark beetle *Polygraphus rufipennis* (Kby.) | Black spruce | Northern Peninsula<br>Eastern Labrador | High numbers found on wind-thrown black spruce. |
| Frost damage | Several softwood and hardwood species | Throughout Newfoundland; eastern Labrador | Varying degrees of damage occurred in insular Newfoundland. In eastern Labrador up to 70% damage was recorded to 50% of the white birch stand. |
| Gray mold blight *Botrytis cinerea* Pers. | Japanese larch | Central Newfoundland | Low incidence. Seedlings affected. |
| Green balsam looper *Cladara limitaria* (Wlk.) | Balsam fir | Western and eastern Newfoundland | High numbers found along Cat Arm River Road in western Newfoundland and current defoliation of 20%. |
| Greenheaded spruce sawfly *Pikonema dimmockii* (Cress.) | Black spruce<br>White spruce | Western Newfoundland<br>Eastern Labrador | Low populations. No significant defoliation. |
| Ice storm damage | Softwood and hardwood species | Avalon Peninsula | Considerable damage to Scots pine, trembling aspen, pin cherry, and white birch in Conception Bay areas and to ornamental trees in and around St. John's. |
| Ink spot *Ciborinia whetzelii* (Seav.) Seav. | Trembling aspen | Eastern Labrador | Low incidence. |
| Larch sawfly *Pristiphora erichsonii* (Htg.) | Tamarack | Western and eastern Newfoundland | Low to high populations. Defoliation ranged from light to severe on the Avalon Peninsula. |
| Leaf blight *Entomosporium mespili* (D.C. ex Duby) Sacc. | Hawthorn | Mount Pearl | New record; 30% of the foliage affected. |

## Newfoundland Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Leaf blister *Taphrina caerulescens* (Desm.) Tul. | Red oak | Eastern Newfoundland | New record; 5% of the foliage affected. |
| *Taphrina populina* Fr. | Hybrid poplar Lombardy poplar | Western, central and eastern Newfoundland Avalon Peninsula | Up to 35% of the foliage affected in western Newfoundland. |
| Leaf rust *Melampsora abieti-capraearum* Tub. | Pussy willow | Eastern Newfoundland | Moderate incidence with up to 40% of the foliage affected. |
| Leaf scorch | White birch | Central Newfoundland | 80% damage to one tree. |
| Leaf and shoot blight *Pollacia elegans* Serv. | Silver poplar Balsam poplar | Western Newfoundland | Low incidence; 20% of the foliage affected. |
| *Venturia macularis* (Fr.) Müll & Arx | Trembling aspen | Throughout Newfoundland Eastern Labrador | High incidence on regeneration in a control burn in western Newfoundland. Moderate incidence near Goose Bay in eastern Labrador. Light to moderate incidence elsewhere. |
| Leaf spot *Marssonina brunnea* (Ell. & Ev.) Sacc. | Berlin "Hybrid" poplar | Avalon Peninsula | High incidence; 100% of hybrid poplar were affected with up to 95% of the foliage affected. |
| *Phyllosticta* sp. | American mountain ash | Western Newfoundland Avalon Peninsula | Low to moderate incidence on few trees. |
| Mountain ash sawfly *Pristiphora geniculata* (Htg.) | American mountain ash | Western Newfoundland Avalon Peninsula | Low to high numbers. Severe defoliation on scattered ornamentals in western Newfoundland. |
| Mourning cloak butterfly *Nymphalis antiopa* (L.) | Willow American mountain ash Misc. shrubs | Western Newfoundland Avalon Peninsula Eastern Labrador | Low to moderate numbers. A trace to severe defoliation in western Newfoundland. Light defoliation in eastern Labrador. |
| Nectria canker *Nectria cinnabarina* (Tode ex Fr. )Fr. | Hardwoods | Urban areas | Moderate incidence; up to 20% of the branches are showing canker and dieback symptoms. |
| *Nectria galligena* Bres. | Maple | Central Newfoundland | Cankers are visible on branches. |
| Needle cast *Hypodermella laricis* Tub | Tamarack | Central Newfoundland | Moderate incidence on scattered trees. |
| *Isthmiella crepidiformis* (Darker) Darker | White spruce | Avalon Peninsula | Affected 5% of the foliage on 1% of the trees. |
| Needle cast *Isthmiella faulii* (Darker) Darker | Balsam fir | Central Newfoundland | A few roadside trees affected. |

## Newfoundland Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Needle rusts<br>*Chrysomyxa ledicola* Lagh. | Black spruce<br>Blue spruce<br>White spruce<br>Sitka spruce | Central Newfoundland<br>Avalon Peninsula | Up to 40% of the new foliage of blue spruce was affected on some trees; 5% of the foliage of black spruce seedlings was infected in a greenhouse on the Avalon Peninsula; 5% needle damage to Sitka spruce saplings in a plantation in central Newfoundland. |
| *Pucciniastrum epilobii* Otth | Balsam fir | Central Newfoundland | High incidence; up to 100% of the new foliage was affected on 70% of young balsam fir. |
| Orange spruce needleminer<br>*Coleotechnites piceaella* (Kft.) | Balsam fir | Western and eastern Newfoundland | Low numbers. No significant damage. |
| Phomopsis blight<br>*Phomopsis juniperovora* Hahn | Common juniper | Avalon Peninsula | Up to 10% of the foliage was affected on ornamental trees in the St. John's area. |
| Poplar serpentine leafminer<br>*Phyllocnistis populiella* Cham. | Trembling aspen<br>Balsam poplar<br>Speckled alder | Western and eastern Newfoundland, eastern Labrador | Severe damage in western Newfoundland and eastern Labrador. A trace to moderate damage recorded elsewhere. |
| Purple eye spot<br>*Phyllosticta minima* (Berk. & Curt.) Underw. & Earle | Red maple | Western Newfoundland | Low incidence; up to 20% of the foliage was affected on young maples. |
| Red flag<br>*Fusicoccum abietinum* (Hartig) Prill. & Del. | Balsam fir | Avalon Peninsula | Up to 10% of the foliage was affected on 10% of the trees. |
| Redlined conifer caterpillar<br>*Feralia jocosa* (Gn.) | Balsam fir<br>White spruce | Western and central Newfoundland | Low numbers. No significant defoliation. |
| Roadside damage | Balsam fir | Northern Peninsula | Common along Roddickton Road. |
| Root collar weevil<br>*Hylobius* sp. | Scots pine<br>Balsam fir<br>Black spruce<br>White spruce | Central and eastern Newfoundland | An estimated 10-20% of the trees in a Sitka spruce plantation were dead and dying and approximately 30-40% of the seedlings in a white spruce plantation were affected in central Newfoundland. |
| Rust gall<br>*Gymnosporangium cornutum* Arth. ex Kern | American mountain ash | Avalon and Baie Verte Peninsulas | Low incidence. |
| Rusty tussock moth<br>*Orgyia antigua* (L.) | Balsam fir<br>White birch<br>Willow | Western and eastern Newfoundland, eastern Labrador | High population found at one location in eastern Newfoundland. |
| Satin moth<br>*Leucoma salicis* (Linn.) | Trembling aspen<br>Willow | Western, central and eastern Newfoundland | Light to moderate numbers; 90% defoliation on one ornamental willow recorded at Portugal Cove in eastern Newfoundland. Light damage elsewhere. |
| Spruce bud moth<br>*Zeiraphera canadensis* Mut. & Free. | White spruce<br>Black spruce | Western Newfoundland | Populations low; 10% damage recorded on white spruce in western Newfoundland. |

## Newfoundland Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun. | White spruce<br>Sitka spruce<br>Black spruce<br>Balsam fir<br>Tamarack | Western and eastern Newfoundland | Low populations. No significant damage. |
| Spruce cone gall midge *Dasineura canadensis* Felt | White spruce | Western and eastern Newfoundland. | Low numbers in cone collections. |
| Spruce cone maggot *Delia anthracina* (Czerny) | White spruce<br>Black spruce<br>Balsam fir | Western and eastern Newfoundland | Low numbers in cone collections. |
| Spruce seed moth *Cydia strobilella* (L.) | Black spruce<br>White spruce | Western Newfoundland | Low numbers in cone collections. |
| Striped alder sawfly *Hemichroa crocea* (Geoff.) | Speckled alder | Western and eastern Newfoundland, eastern Labrador | High populations. Defoliation ranged from a trace to 80%. |
| Taphrina witches' broom *Taphrina cerasi* (Fckl.) Sadeb. | Pin cherry | Avalon Peninsula | Up to 10% of the foliage was affected on some trees in St. John's area. |
| Whitemarked tussock moth *Orgyia leucostigma* (J.E. Smith) | Birch<br>Alder | Western Newfoundland | Infestation along the Bottom Brook Road continued for the second consecutive year. Severe damage occurred on hardwoods, mostly birch and alder, although some spruce and larch seedlings in a nearby plantation were also attacked. A virus was sprayed in the infestation as a biological control. Light defoliation of white birch and speckled alder also occurred near Overfalls Brook in the Codroy Valley. |
| Willow blight *Fusicladium saliciperdum* (All. & Tub.) Lind. | Laurel willow<br>Willow | Western Newfoundland<br>Avalon and Burin Peninsulas | Moderate incidence on laurel willows on the Burin Peninsula. |
| *Physalospora miyabeana* Fukushi | Willow | Western Newfoundland | Low incidence on few roadside trees. |
| Willow sawfly *Nematus limbatus* (Cress.) | Willow | Western and central Newfoundland | Moderate to high populations; 100% defoliation recorded on two trees in western Newfoundland. |
| Winter drying | Softwood species | Throughout Newfoundland | High incidence in several areas where up to 100% corsican pine; 80% Austrian pine; 75% Sitka spruce; black spruce nursery stock and exposed balsam fir stands showed symptoms. |
| Witches' broom *Melampsorella caryophyllacearum* Schroet. | Balsam fir | Northern Peninsula | Low incidence. Common throughout area. |

# Other Insects, Diseases and Damage

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Alder flea beetle<br>*Altica ambiens alni*<br>Harrison | Alder | Maritime provinces | Overall intensity declined in western New Brunswick but moderate and severe patches of browning extended from Charlotte County in the south to Edmundston, Madawaska County in the north. Numerous patches of light, moderate and severe browning were noted throughout Pictou, Antigonish, and Victoria counties, becoming scattered patches along roadsides and in old fields in southwestern Nova Scotia. Populations remained low in Prince Edward Island except for small patches of severe browning at Brookvale and North Granville, Queens County, and between Montague and Valleyfield, Kings County. |
| Ambermarked birch leafminer<br>*Profenusa thomsoni*<br>Konow | White birch | New Brunswick<br>Nova Scotia | In New Brunswick, low populations at two locations in Kent County, one each in St. John and York counties. In Nova Scotia, a low population affecting 4% of leaves at one location in Queens County. |
| Armillaria root rot<br>*Armillaria mellea*<br>(Vahl ex Fr.) Kummer | Conifers | Maritime provinces | Tree mortality of both young and old trees is common. In New Brunswick, 22% of 141 spruce and pine plantations surveyed had at least some mortality due to this disease. The root rot is one of the major factors associated with Stillwell's Syndrome, the sudden death of balsam fir trees. |
| Ash yellows | Ash | Maritime provinces | This disease, apparently caused by a mycoplasma-like organism, has not been found in the region to date. The symptoms include slow growth, gradual dieback, small leaves and early foliage coloration. This disease is present in parts of the United States and is a concern for plant quarantine officials. |
| Aspen leafrollers<br>*Pseudexentera oregonana*<br>(Wlsm.)<br>*Epinotia criddleana* (Kft.)<br>Birch-aspen leafroller<br>*E. solandriana* (L.)<br>Darkheaded aspen leafroller<br>*Anacampsis innocuella*<br>(Zell.)<br>Large aspen tortrix<br>*Choristoneura conflictana*<br>(Wlk.)<br>Lightheaded aspen leafroller<br>*Anacampsis niveopulvella*<br>(Cham.)<br>Spotted aspen leafroller<br>*Pseudosciaphila duplex*<br>(Wlsm.) | Largetooth aspen<br>Trembling aspen | Maritime provinces | Leafrolling, mostly of trembling aspen, common throughout the region but restricted mainly to trace and light levels. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Aspen webworm *Tetralopha aplastella* (Hulst)<br>Lesser aspen webworm *Meroptera pravella* (Grt.) | Trembling aspen | Maritime provinces | Negative in 1986. This decline is connected with the overall decline in forest tent caterpillar throughout the region. |
| Bagworm *Thyridopteryx ephemeraeformis* (Haw.) | Spruce | Nova Scotia | Found at Bridgewater, Lunenburg County. This is a new record for the province. |
| Balsam bark weevil *Pissodes dubius* Rand. | Balsam fir<br>Red spruce<br>White spruce | Maritime provinces | In New Brunswick common on dead and dying balsam fir and to a lesser extent, white spruce and red spruce. Approximately 13% of balsam fir affected at 25 locations in 12 counties. At Dalvay, Queens County, Prince Edward Island, of 25 white spruce trees examined 16% were dead and 12% living but infested. In Nova Scotia, found on balsam fir at locations in Inverness, Guysborough and Halifax counties. |
| Balsam fir sawfly *Neodiprion abietis* (Harr.) | Balsam fir<br>Black spruce<br>Red spruce<br>White spruce | Nova Scotia<br>New Brunswick<br>Prince Edward Island | Present in low numbers at a few locations scattered throughout the region. |
| Balsam fir root aphid *Prociphilus americanus* (Walker) | Balsam fir | New Brunswick | Present in Christmas tree plantations at Connors, Madawaska County, and Cape Spear, Westmorland County. |
| Balsam gall midge *Paradiplosis tumifex* Gagne | Balsam fir | Maritime provinces | Populations generally low throughout. The percentage of needles infested exceeded 20% at only one of the more than 1100 assessed locations in the Maritimes. |
| Balsam shootboring sawfly *Pleroneura brunneicornis* Roh. | Balsam fir | New Brunswick<br>Nova Scotia | In New Brunswick, an average of 3% of shoots were infested at 15 scattered locations; in Nova Scotia, 0.6% at 22 locations. |
| Balsam twig aphid *Mindarus abietinus* Koch. | Balsam fir | Maritime provinces | Populations generally low. The highest infestation observed on Cape Breton Island, N.S., where 35% of the shoots were affected in two silviculture treated stands. |
| Balsam woolly adelgid *Adelges piceae* (Ratz.) | Balsam fir | Maritime provinces | In New Brunswick, very light stem attack was reported from three locations, one each in Charlotte, St. John and York counties. In Nova Scotia, the insect continued to deform trees, especially in coastal areas, causing gouty twigs and umbrella tops. Stem attack was present on 25% of the trees at Marie Joseph, Guysborough County. One location in southern Kings County, Prince Edward Island had very light stem wool. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Beech bark disease<br>*Nectria coccinea* var. *faginata* Lohm., Wats. & Ayers<br>Beech scale<br>*Cryptococcus fagisuga* Lind. | Beech | Maritime provinces | Cankered trees remain common throughout the region. In New Brunswick at 14 locations, infections ranged from 32% of trees at Allardville to 100% at Allardville East, Gloucester County; elsewhere five widely scattered locations had from 90–100% of trees cankered. At Scotch Hill, Pictou County, Nova Scotia, 100% of trees were severely cankered. |
| Birch casebearer<br>*Coleophora serratella* (L.) | White birch<br>Wire birch | Maritime provinces | Various levels of foliage browning was common in many areas throughout the region. |
| Birch sawfly<br>*Arge pectoralis* (Leach) | White birch | New Brunswick<br>Nova Scotia | In New Brunswick at Martin Head, St. John County, an average of 16% of the leaves were affected on about half of the trees. Found at four locations in eastern Nova Scotia, but noticeable leaf damage was restricted to one area at MacIntosh Brook, Inverness County where the insect was present in combination with the birch skeletonizer, which was the more common organism. |
| Birch leafminer<br>*Fenusa pusilla* (Lep.) | Wire birch | Maritimes provinces | Present throughout but population level much reduced from 1985 especially in New Brunswick. Foliage discoloration and rarely more than trace or light. |
| Birch skeletonizer<br>*Bucculatrix canadiensisella* Cham. | White birch | Nova Scotia | An outbreak on Cape Breton Island continued in 1986. The area affected increased in size but leaf browning was less severe than last year. |
| Bruce spanworm<br>*Operophtera bruceata* (Hlst.) | Sugar maple<br>Red maple | Maritime provinces | Populations decreased throughout the region. In New Brunswick, light defoliation occurred on sugar maple at scattered locations in Restigouche and Gloucester counties. Populations were negligible in Nova Scotia. Not found in Prince Edward Island. |
| Cedar leafminers<br>*Argyresthia aureoargentella* Brower<br>*Argyresthia freyella* Wlshm.<br>*Coleotechnites thujaella* (Kft.) | Cedar | New Brunswick<br>Prince Edward Island | In Prince Edward Island, occurrence and abundance of leafminers increased in Prince County. Virtually all stands between O'Leary in the northwest part of the county and Summerside in the southeast sustained moderate or severe leaf browning. Chronic attack in the Miscouche, Muddy Creek, Sandy Cove areas has resulted in many dead branches and tree mortality. In New Brunswick, attack was concentrated in parts of Charlotte and St. John counties (see Deterioration of cedar). |
| Cherry casebearer<br>*Coleophera pruniella* Clem. | Trembling aspen | Prince Edward Island | The number of locations with damage declined dramatically from 1985. Three locations in Kings County and one in Queens County had moderate brownings. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Cherry blight | Pin cherry | Prince Edward Island<br>Nova Scotia | Continued moderate and severe damage at many locations in Kings and Queens counties and a few locations in Prince County, Prince Edward Island. Light and moderate damage were widespread throughout Nova Scotia. |
| Condition of spruce | White spruce | New Brunswick | Mature spruce trees in the Robinsonville area of Restigouche County, weakened by repeated spruce budworm attacks over the years, are being attacked and killed by stem weevils, horntails, bark beetles, whitespotted sawyer beetles, and Armillaria root rot. The area affected covers approximately 144 $km^2$ and is bordered on the west by the Restigouche and Upsalquitch Rivers and extends from Robinsonville in the south, to Flatlands in the North and East to near Christopher Brook. |
| Conifer aphids<br>*Cinara* spp. | Balsam fir<br>Black spruce<br>Eastern white pine<br>Jack pine<br>Red spruce<br>Tamarack<br>White spruce | Maritime provinces | Common throughout the region, sometimes affecting the majority of trees in localized situations, but causing little damage. |
| Deer damage | Balsam fir | New Brunswick | Moderate and light browning in a Christmas tree stand at Clair, Madawaska County. |
| Deterioration of cedar | Eastern cedar | New Brunswick | Many cedars with thin crowns and some tree mortality in parts of Charlotte and St. John counties, with the heaviest concentration of damage east of Saint John city. The cedar leafminer, *Argyresthia aureoargentella* Brower has been present for more than one year and was the most abundant organism found, a species of spider mite. Tetranychidae, cedar leaf blight *Didymascella thujina* (Durand) Maire, and the cedar tree borer, *Semanotus ligneus* (F.) were also present. It is not certain, however, if these organisms are fully responsible for the condition. |
| Dieback | Ash | New Brunswick | This condition persisted at Robinsonville, Restigouche County and Tetagouche River, Gloucester County, where top and branch mortality continued to occur on many trees. |
| Early leaf browning | Largetooth aspen | Nova Scotia | Premature leaf browning and crown deterioration occurred in forest stands east of Garlands Crossing and near Mill Section, Hants County. Leaf spot fungi were present as were a few twig cankers, of uncertain origin. The exact cause of the condition is as yet unexplained. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Eastern blackheaded budworm *Acleris variana* (Fern.) | Balsam fir<br>Spruce | Prince Edward Island | Present in low numbers throughout the region. |
| Eastern dwarf mistletoe *Arceuthobium pusillum* Peck. | Black spruce<br>White spruce | Maritime provinces | Present at low levels throughout the region. |
| Eastern tent caterpillar *Malacosoma americanum* (F.) | Apple<br>Cherry | Maritime provinces | Populations very low in New Brunswick and Prince Edward Island. Present at low levels in eastern Nova Scotia and in Hants, Kings and Annapolis counties, in the western part of the province. |
| Elm leaf beetle *Pyrrhalta luteola* (Mull.) | Elm | New Brunswick | Browning of shade trees was present again in Fredericton, York County, but much less severe than in 1985. |
| Elm leafminer *Fenusa ulmi* Sund. | English elm | Maritime provinces | In Nova Scotia, leaf browning of varying intensity, sometimes severe, occurred in Cape Breton, Pictou, Colchester, Hants, Queens, and Cumberland counties. Intensity of attack in Truro was reduced for the second year. In Prince Edward Island, severe browning in all three counties, with 80–90% at Montague, Kings County. In New Brunswick, light browning on a few trees at Dorchester and Sackville, Westmorland County. |
| European pine sawfly *Neodiprion sertifer* (Geoff.) | Mugho pine<br>Red pine<br>Scots pine | Maritime provinces | Present at low numbers on ornamentals in all three provinces. |
| European pine shoot moth *Rhyacionia buoliana* (D. & S.) | Red pine<br>Scots pine | Maritime provinces | Populations were generally low in most of the region but a red pine plantation at Beauly, Antigonish County, Nova Scotia, had an average of 36% of shoots damaged. At Quispamsis, Kings County, New Brunswick, severe damage made red pine in a 1-ha Christmas tree plantation unmarketable. In Prince Edward Island, young plantations showed a noticeable increase in damage in the central and eastern areas of the province. At Fort Augustus, Granville, Roseberry, and Caledonia, Queens County, 90–100% of the trees were infested with up to 60% shoot damage in 0.5–1.0-ha plantations. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| European spruce sawfly *Gilpinia hercyniae* (Hts.) | Spruce | Maritime provinces | Populations remained low throughout the region, except at the permanent plots at the Acadia Forest Experiment Station, Sunbury County, New Brunswick where larvae per tree have shown a steady increase as follows:<br>1983 0.00 0.20<br>1984 0.13 0.56<br>1985 0.60 1.90<br>1986 1.83 6.16<br>(1st generation / 2nd generation)<br>There have been several brief peaks during the 49 years of continuous monitoring since the very damaging outbreak collapsed in the late 1930s. |
| Fall webworm *Hyphantria cunea* (Dru.) | Deciduous | Maritime provinces | In Nova Scotia, nests were common again on roadside bushes in Yarmouth, Digby, and Queens counties. Nests were common in Prince Edward Island but did not exceed 1 per/km except at Fort Augustus and between Bethel and Mount Herbert, Queens County, with 5 and 7 nests/km respectively. There was a single collection from Gloucester County, New Brunswick. |
| Fall cankerworm *Alsophila pometaria* (Harr.) | Hardwoods | Nova Scotia<br>Prince Edward Island | Various levels of defoliation of maple and oak occurred in patches of various sizes in western Nova Scotia, totalling 23 000 ha. Smaller outbreaks were present in eastern Nova Scotia and in eastern Prince Edward Island. Also common on a variety of ornamental trees throughout the Maritimes. |
| False hornworm *Pheosia rimosa* Pack.<br>Pepper and salt moth *Biston betularia cognataria* (Gn.)<br>Rustylined leaftier *Clostera albosigma* Fitch | Trembling aspen | New Brunswick<br>Nova Scotia | The area that sustained moderate and severe defoliation northeast of Salem Road, Cape Breton County, Nova Scotia in 1985 had light defoliation. |
| Four-eyed spruce bark beetle *Polygraphus rufipennis* (Kby.) | Black spruce<br>Red spruce<br>White spruce | New Brunswick | Observed at eight locations in New Brunswick including 20% of red spruce in a 5-ha area of Fundy National Park and 12% of red spruce at a location on the South Dungarvon River, Northumberland County. At Peabody Lake, Northumberland County, 8% of white spruce were infested and 4% of black spruce at Acadia Forest Experiment Station, Sunbury County. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Frost damage | Conifers<br>Hardwoods | Maritime provinces | Damage was widespread and severe on current balsam fir and spruce foliage throughout much of eastern New Brunswick, resulting in a 40 to 50% reduction in the Christmas tree harvest, where up to 70% of new shoots were destroyed in some stands. In Nova Scotia, damage ranged from 15 to 85% of current balsam fir foliage in areas of Antigonish, Guysborough, Halifax, Pictou, and Cumberland counties. In Prince Edward Island, up to 90% of new white spruce foliage was affected on 60% of the trees in two small areas in Queens County, moderate and severe damage elsewhere including 80% of trembling aspen foliage on a few trees at Granville, Queens County. |
| Globose gall rust<br>*Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka | Jack pine<br>Lodgepole pine<br>Scots pine | Maritime provinces | Common in many areas of New Brunswick where an average of 35% of the trees were infected at 10 locations with a range of infection from 5 to 20%. In Prince Edward Island, present at three locations at low levels and one location also at low levels in Nova Scotia. |
| Hail damage | Balsam fir | New Brunswick | A few trees had broken branches in a 0.25-ha area near Burnthill Brook, Carleton County. |
| Hypoxylon canker<br>*Hypoxylon mammatum* (Wahl.) J.E. Miller | Trembling aspen | Maritime provinces | Near Brockway, York County, New Brunswick, 64% of trees were infected. Light infections were found at nine locations, two each in Kent, York, and Northumberland counties, and one each in Westmorland, Carleton, and Madawaska counties. Trace infections were found at two locations, one each in York and Victoria counties. In Nova Scotia, it is omnipresent with 12% infection at West Linwood, Antigonish County, the highest found. In Prince Edward Island, moderate infection at Harmony, and light infections at two other locations in Prince County, one light and one trace at two locations in Queens County. |
| Ice and sleet damage | Tamarack<br>White pine | Nova Scotia | Tops and limbs were damaged over several square kilometres in the Garden of Eden Barrens in Pictou and Guysborough counties. |
| Jack pine budworm<br>*Choristoneura pinus pinus* Free. | Jack pine | New Brunswick | A few scattered trees were moderately defoliated while remaining trees sustained trace at Little Forks Brook, Kent Co. Elsewhere defoliation was trace to light. |
| Larch casebearer<br>*Coleophora laricella* (Hbn.) | Larch | Nova Scotia | The outbreak reported in 1985 has collapsed. Moderate defoliation occurred only in small patches in both the western and the eastern parts of the province. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Larch needleworm<br>*Zeiraphera improbana*<br>(Wlk.) | Tamarack | Nova Scotia | Trace to moderate defoliation was observed at the Garden of Eden Barrens, Guysborough County. Populations elsewhere low except on Cape Breton Island where 20–40 ha of moderate-to-severe defoliation was found in the St. Peters Junction - Port Richard - Port Malcolm area of Richmond County. |
| Larch sawfly<br>*Pristiphora erichsonii*<br>(Htg.) | Tamarack | Maritime provinces | Populations remained low throughout the region. Found at two locations each in New Brunswick and Nova Scotia, and at one location in Prince Edward Island; defoliation did not exceed light. |
| Large aspen tortrix<br>*Choristoneura conflictana*<br>(Wlk.) | Largetooth aspen<br>Trembling aspen | Maritime provinces | Leafrolling at low levels at scattered locations except two areas in Pictou County, Nova Scotia, where the insect caused moderate damage over about 70 ha. In the area near Granton, Pictou County, the forest tent caterpillar was also involved. |
| Leaf blotch<br>*Guignardia aesculi*<br>(Peck.) V.W. Stew | Horse-chestnut | Maritime provinces | Browning was widespread and variable on foliage wherever horse-chestnut was found in the region. In New Brunswick, only light and moderate browning was present on Deer Island, Campobello Island, and St. Stephen, Charlotte County; this represents a significant decline from 1985. In Nova Scotia, light and moderate damage was observed at Whycocomagh and Mabou, Inverness County; Baddeck, Victoria County; Sydney, Cape Breton County; Plainfield and Poplar Hill, Pictou County. Damage did not exceed light elsewhere in the province. In Prince Edward Island, severe browning was observed at Montague and Kilmuir, Kings County; moderate and severe at St. Eleanors, Norboro, and Summerside, Prince County; Souris and Sturgeon, Kings County; and Belfast and Marshfield, Queens County. Foliage discoloration did not exceed light elsewhere. |
| Leaf rollers<br>*Caloptilia* sp. | White birch<br>Yellow birch | New Brunswick | Populations continued to increase and cause significant leaf rolling of white birch and to a lesser extent yellow birch throughout much of the northern half of New Brunswick, and was also more damaging and widespread in much of the southern part of the province. |
| Leaf spot<br>*Drepanopeziza tremulae*<br>Rimpau | Trembling aspen | Nova Scotia<br>Prince Edward Island | The moderate and severe leaf browning reported from locations in Richmond County, Nova Scotia, disappeared in 1986; at North River and North Wiltshire, Queens County, Prince Edward Island, it declined to light discoloration on a few trees. |
| Leaf and twig blight<br>*Venturia macularis* (Fr.)<br>Muell & Arx. | Trembling aspen | New Brunswick<br>Prince Edward Island | Common throughout New Brunswick where an average of 15% of shoots were damaged at 35 scattered locations in Prince Edward Island, found at low levels at five locations. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Lesser maple spanworm *Itame pustularia* (Gn.) | Red maple | Maritime provinces | Populations low throughout. |
| Maple leafroller *Sparganothis acerivorana* Mack. | Red maple<br>Sugar maple | Maritime provinces | In Prince Edward Island, populations and damage increased. At 39 locations leafrolling averaged 38%. Common throughout New Brunswick but leafrolling was light, averaging less than 10% at 59 locations; in Nova Scotia populations were low. |
| Mites *Oligonychus milleri* (McGregor) | Pine | Maritime provinces | Foliage discoloration widespread in New Brunswick but not exceeding light; severe or moderate in plantations on the Trafalgar burn area in eastern mainland Nova Scotia and light elsewhere in many areas; observed at only one location in Prince Edward Island. |
| Mineral deficiency | Jack pine<br>White pine | New Brunswick | What appeared to be mineral deficiency caused foliage discoloration of 50% of roadside pine trees in the Crow Hill area, York County and discoloration of 1984 and 1985 foliage of white pine at Kouchibouguac National Park, Kent County |
| Mountain ash sawfly *Pristiphora geniculata* (Htg.) | Mountain-ash | Maritime provinces | In Prince Edward Island, moderate defoliation was observed at Brackley Beach, Stanhope, New London, and Springfield, Queens County, and Montague, Kings County; in Nova Scotia and New Brunswick, varying levels of defoliation, typically trace and light. |
| Northern pitch twig moth *Petrova albicapitana* (Busck) | Jack pine<br>Lodgepole pine | Maritime provinces | In New Brunswick, present in jack pine plantations and stands although numbers were usually not high; pitch masses were easy to find. The highest numbers occurred at Forks Stream, Sunbury County, where nodules were found on 70% of the trees with 20% at a location near Allardville, Gloucester County. Numbers were very high on lodgepole pine at Acadia Station, Sunbury County, where all trees were infested in a small plantation and a few killed by repeated attacks. In Nova Scotia, the highest incidence was at Black Brook Cove, Victoria County, where 60% of the trees had 1-2 nodules each. In Prince Edward Island, a few nodules were found on jack pine at Fort Augustus, Queens County. |
| Oak leaf shredder *Croesia semipurpurana* (Kft.)<br>and<br>Oak leafroller *Pseudexentera cressoniana* (Clem.) | Oak | Maritime provinces | Defoliation ranged from 33 to 72% (avg. 50%) on study plots in Lunenburg and Queens counties, Nova Scotia; was 90% in a small area in Queens Co., Prince Edward Island; and 25 to 50% in an area in Queens Co., New Brunswick. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Obliquebanded leafroller *Choristoneura rosaceana* (Harr.) | Largetooth aspen<br>Mountain maple<br>Red maple<br>Sugar maple<br>Trembling aspen<br>White birch<br>Yellow birch | Maritime provinces | Caused light defoliation at scattered locations in New Brunswick, eastern Nova Scotia, and Prince Edward Island. |
| Ocean salt spray damage | Alder<br>Cherry<br>Red maple<br>White birch | Nova Scotia | Moderate foliage browning common at Black Brook Cove, Victoria County. |
| Orangehumped mapleworm *Symmerista leucitys* Francl. | Beech<br>Sugar maple | Nova Scotia | The population decline first noted in 1985 continued and the insect is now at endemic levels. |
| Pine leaf adelgid *Pineus pinifoliae* (Fitch) | Red spruce<br>White pine | New Brunswick | Although common in 1985, six of seven locations sampled in 1986 were negative. At West Gore Road, Hants county, 4% of white pine shoots were affected. |
| Poplar serpentine leafminer *Phyllocnistis populiella* Cham. | Trembling aspen | Northern New Brunswick | Populations remained high in essentially the same areas affected in previous years. An average of 31% of leaves mined in the province, ranging from 0% in the south to 100% in some areas in the north. |
| Poplar leaffolding sawfly *Phyllocolpa* sp. | Trembling aspen | Maritime provinces | Present throughout most of New Brunswick; counts made at 15 locations in 8 counties averaged 9% of the leaves affected and ranged from 3 to 11% on 60% of the trees. In Prince Edward Island, an average of about 28% of the leaves were folded at 12 locations scattered throughout the province. Occurred at a few locations in Colchester and Pictou counties, Nova Scotia, with 9% the highest level of leaves affected. |
| Poplar petiolegall moth *Ectoedemia populella* Busck | Trembling aspen | Prince Edward Island | Present throughout the Province. At Dalvay, Queens County about 15% of leaf petioles were infested. |
| Premature needle loss | Black spruce<br>Red spruce | New Brunswick | Loss of 1985 foliage in plantations in parts of Victoria and Madawaska counties. Further study is required to determine the cause of this problem. |
| Porcupine damage | Balsam fir<br>Beech<br>Jack pine<br>Red pine<br>Sugar maple<br>Tamarack<br>White pine | New Brunswick<br>Nova Scotia | Common throughout New Brunswick and Nova Scotia. About 13% of trees damaged at 14 locations in New Brunswick. Damage ranged from 16 to 63% in affected pine plantations in eastern Nova Scotia and up to 92% in the western part of the province. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Roadside salt damage | Conifers | Maritime provinces | Foliage reddening, mainly of white pine and to a lesser extent red pine, present throughout New Brunswick and Nova Scotia. Other hosts affected to a lesser extent were Scots pine, eastern hemlock, spruce and fir. In Prince Edward Island, white spruce, cedar, red pine, and Scots pine were severely and moderately discolored in parts of Prince and Queens counties. |
| Rabbit damage | Black spruce<br>Jack pine | New Brunswick | Rabbits girdled and killed a few scattered young trees in a plantation at Forks Stream, Queens County, scattered trees at Keswick River, and a few black spruce along Napadogan Stream, York County. |
| Saddled prominent<br>*Heterocampa guttivitta* (Wlk.) | Sugar maple | Nova Scotia<br>New Brunswick | Light defoliation on sugar maple 7.5 km northwest of Economy Lake, Colchester County, Nova Scotia. The scattered areas of defoliation noted in Pictou and Antigonish County, Nova Scotia in 1985 disappeared. Several larvae collected at Berryton, Alberta County, New Brunswick. |
| Satin moth<br>*Leucoma salicis* (L.) | Carolina poplar<br>Silver poplar<br>Trembling aspen | Maritime provinces | At Popple Depot, Northumberland County, New Brunswick, approximately 100 ha of trembling aspen had moderate defoliation, with a central 10-ha area of severe defoliation. This is the same outbreak area reported on in 1984 which subsided in 1985 and then rebounded in 1986. Ornamental Carolina poplars were severely defoliated in New Maryland, York County. In Prince Edward Island, defoliation subsided at Hunter River, Queens County, but persisted and caused severe defoliation of silver poplar at St. Anthony, Prince County. Severe spot defoliation of ornamentals was noted at Cherry Valley, North Rustico, near Kingston, Queens County and Five Houses, Kings County. Defoliation reported in 1985 in Hants County, Nova Scotia subsided and the entire province had very low populations. |
| Spider mite<br>*Oligonychus laricis* Reeves | Larch | New Brunswick | Trace to moderate needle discoloration of grafted stock in a plantation at the Acadia Forest Experiment Station. This is the first record of this species in the Maritimes. |
| Snow damage | Jack pine<br>Red pine<br>White pine | New Brunswick<br>Nova Scotia | The weight of snow caused broken branches and tops to 5% of jack pine trees in a 40-ha plantation at Napadogan, also present at South Tay, and on the North Branch of the Keswick River, York County, New Brunswick. In Nova Scotia, 64% of white pine trees were damaged at Garden of Eden Barrens, Guysborough County; 28% of white pines at Bryden Brook, Pictou County; and 68% of jack pine at Black Brook Cove, Victoria County. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Spring cankerworm *Paleacrita vernata* (Peck) | Elm | Nova Scotia | Light and moderate defoliation was noted on ornamental elm trees at Windsor and Hantsport, Hants County; Kentville, and near Kingston, Kings County; and Middleton, Annapolis County. |
| Spruce bud midge *Rhabdophaga swainei* Felt | Black spruce<br>White spruce | Maritime provinces | Populations remained low but were widespread throught the region. Numbers were highest at Askilton, Inverness County, Nova Scotia, where 11% of the buds were infested on 5% of the white spruce trees. In Prince Edward Island, infestations ranged up to 8% of buds on 40% of white spruce trees at Brookvale and Mount Vernon, Queens County. In New Brunswick, 5% of the buds were infested on 70% of white spruce at one location in Madawaska County. |
| Spruce bud scale *Physokermes piceae* (Schr.) | Balsam fir<br>Black spruce<br>Red spruce<br>White spruce | New Brunswick | Present at varying levels of intensity in plantations, natural forests and ornamentals at locations scattered throughout the province. The highest infestation level occurred in a black spruce plantation in Victoria County where 25 to 100% of the shoots were attacked on all trees examined. |
| Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun. | Spruce | Maritime provinces | Populations remained low. |
| Spruce spider mite *Oligonychus ununguis* (Jacobi) | Pine<br>Spruce | Maritime provinces | Caused various levels of needle discoloration, mainly on ornamental trees. |
| Squirrel damage | Jack pine | New Brunswick | Squirrels removed cones from a few trees causing red flagging of up to 1% of branches along the South Tay River, York County. The condition occurred at numerous other locations scattered throughout the province. |
| Striped alder sawfly *Hemichroa crocea* (Geoff.) | Alder | Maritime provinces | Severe defoliation occurred in a 2-ha area at Grand Harbour, Charlotte County, New Brunswick, in a small area of Keppoch, Pictou County, Nova Scotia, and moderate defoliation of scattered alders at Goose River, Kings County, Prince Edward Island. |
| Sugar maple borer *Glycobius speciosus* (Say) | Red maple<br>Sugar maple | New Brunswick | Twenty-one sugar maple locations were assessed in New Brunswick. At Ammon Road, Westmorland County, 36% of the trees were damaged. Elsewhere in the province, damage at eight locations ranged from 12-25%, seven locations were 4-8% and five locations were negative. Six red maple locations were assessed in New Brunswick with 20% of the trees damaged at Upper Buctouche, Kent County and four locations with 4-8% damage and one location negative. |
| Sulphur dioxide damage | Hardwoods<br>Conifers | New Brunswick | Damage to various tree species was moderate and severe in some conifer plantations near a base metal smelter in Gloucester County. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Target canker (probably a *Nectria*) | Red maple<br>Sugar maple<br>White birch | New Brunswick | Present on 7.5% of sugar maples in eight stands in six counties in the eastern part of the province, also present on 8% of red maple in a stand in Kent County. At Magaguadavic Lake, York County, 32% of white birch stems were cankered. |
| Tip blight *Delphinella balsamae* (Waterm.) E. Muell. | Balsam fir | Nova Scotia<br>New Brunswick | A few scattered trees were affected near Earltown Lake, Colchester County. Not found in New Brunswick where up to 75% of current shoots were affected on scattered trees in Fundy National Park, Albert County, in 1985. |
| Uglynest caterpillar *Archips cerasivorana* (Fitch) | Cherry | Maritime provinces | In New Brunswick, a nest count of 35 per 100 $m^2$ was made at Tay Mills, York County. At three scattered locations in Kings, York, and Victoria counties, nest counts were 7, 2, and 3 per 100 $m^2$ respectively. Numbers were low elsewhere in the region. |
| Wax filament scale *Xylococculus betulae* (Perg.) | Beech<br>White birch | New Brunswick<br>Nova Scotia | Moderate and light infestations on white birch at 10 locations in New Brunswick; present on 80% of beech trees at Scotch Hill, Pictou County, Nova Scotia, and in a few beech stands in New Brunswick. |
| Whitemarked tussock moth *Orgyia leucostigma* (J.E. Smith) | Conifers<br>Hardwoods | Nova Scotia<br>New Brunswick | Populations have been increasing. Since 1984, the insect has become common. Noticeable defoliation occurred in patches in three distinct areas in Guysborough and Halifax counties in eastern mainland Nova Scotia. |
| White pine cone beetle *Conophthorus coniperda* (Sz.) | White pine | New Brunswick | This insect causes loss of 2nd year cones by attacking the base of the cone stem causing infested cones to shrivel and drop. At Fredericton Junction, and in the Burpee Game Management Area, Sunbury County, cone losses were 95% and 30 to 40% respectively, at mid-season. Damage was also reported near Doaktown, Northumberland County, and Cranberry Lake, Queens County. The loss of cones and seed is a matter of concern since some white pine is now included in planting programs. |
| White pine blister rust *Cronartium ribicola* J.C. Fisch. | White pine | New Brunswick | Continues to be present in white pine throughout New Brunswick. Near Brockway, York County, 88% of the trees in a small area were affected, and 48% at Scotch Ridge, Charlotte County. In Restigouche County, 60% of small trees are affected in an area near the southeast Upsalquitch River. Elsewhere forest trees and ornamentals were affected at scattered locations. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| White pine needle blight | White pine | Maritime provinces | This condition was not as common in New Brunswick as in 1985 but affected scattered trees throughout the province at low levels of intensity. In Nova Scotia, up to 80% of the trees were lightly affected in the Rossignol Lake area of Queens County, and in Prince Edward Island, one tree was moderately browned at Brookvale, Queens County. |
| White pine weevil<br>*Pissodes strobi* (Peck) | Jack pine<br>Scots pine<br>White pine<br>White spruce | Maritime provinces | Present throughout the region. In Charlotte County, New Brunswick, 100% of white pine were infested at Scotch Ridge; 92% at Brockway, York County; 20% of white pine in a small area of Kouchibouguac National Park, Kent County; and varying levels of infestation at numerous other locations in the province. In Nova Scotia, 44% of white pine were affected in an area of Kejimkujik National Park, Queens and Annapolis counties; 8% of white pine at Hunters Mountain, Victoria County, and Garden of Eden Barrens, Guysborough County. In Prince Edward Island, a few white pine leaders were affected at Brookvale, Queens County; on 10% of white spruce near Dalvay, in the Prince Edward Island National Park; and on a few white spruce at Howards Cove, Prince County. |
| Whitespotted sawyer<br>*Monochamus scutellatus* (Say) | Balsam fir<br>White spruce | New Brunswick<br>Nova Scotia | Red flagging of balsam fir shoots caused by adult feeding on the underside of smaller branches was very common on all ages of trees in western New Brunswick. Populations were high in dead and dying trees in much of western and northern New Brunswick where more than 8% of fir stems in some areas were infested. In Nova Scotia, many balsam fir trees were infested on the Highlands area of Inverness and Victoria counties. |
| Willow blight<br>*Venturia saliciperda* Nuesch | Willow | Maritime provinces | Present at low levels in New Brunswick. In Nova Scotia, severe browning throughout the western half of the province and varying degrees of browning in Colchester, Pictou, Antigonish, and Halifax counties. In Prince Edward Island, up to 80% of foliage was browned at four scattered locations in Prince County and two locations in Kings County. |
| Willow flea weevil<br>*Rhynchaenus rufipes* (Lec.) | Willow | Maritime provinces | Severe and moderate browning of ornamental willows in parts of Westmorland, Kent, Madawaska and Northumberland, Gloucester, and Restigouche counties, New Brunswick; throughout much of Nova Scotia where bayleaf willow is present; caused severe leaf browning of ornamentals throughout Prince County and at scattered locations in Queens and Kings counties in Prince Edward Island. |

## Maritimes Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Wind damage | Conifers<br>Hardwoods | Maritime provinces | Strong winds in northern new Brunswick in early June damaged up to 72% of hardwood foliage in some areas. Scattered softwood trees were blown down along roadsides and at the edges of cutover areas especially in the Halfway Depot - Summit Depot to Kedgwick areas of Madawaska and Restigouche counties. In Nova Scotia, a few scattered trees were affected at Whycocomagh, Inverness County and St. Peters, Richmond County. Light damage of red maple foliage occurred on a few trees at Summerside, Prince County and Meadowbank, Queens County, Prince Edward Island. |
| Winter drying | Balsam fir<br>Black spruce<br>Cedar<br>Jack pine<br>Red pine<br>Scots pine<br>White pine<br>White spruce | New Brunswick<br>Prince Edward Island | In New Brunswick, severe and moderate browning of Scots pine at Prime and near St. Basile, Madawaska County, of 40% of Scots pine at Lower Caverhill, York County. The tops of 75% of black spruce in a transplant bed were moderately browned at Juniper, Carleton County; and up to one-third of red spruce foliage on understory trees at a location on the Dungarvon Road, Northumberland County. In Prince Edward Island, severe foliage browning occurred on various tree species in scattered locations throughout the province. At Dalvay Beach, Queens County, 40% of red pine were affected. |
| Winter moth<br>*Operophtera brumata* (L.) | Deciduous | Nova Scotia | Collected in low numbers from a few widely scattered locations; damage negligible. |
| Yellowheaded spruce sawfly<br>*Pikonema alaskensis* (Roh.) | Black spruce<br>White spruce | Prince Edward Island | Up to 9% mortality of black spruce with defoliation ranging from light to severe on 75% of remainder in a 1.5-ha area at Dromore, Queens County. Near Peaks, Kings County, populations increased and caused up to 70% defoliation on 11% of trees and lower levels of defoliation on 60% of trees in a 5-ha, 9-year-old black spruce plantation. Populations collapsed at four locations in Queens County where light and moderate defoliation occurred in 1985. |
| Yellow witches' broom<br>*Melampsorella caryophyllacearum* Schroet. | Balsam fir | Maritime provinces | Presents a problem in Christmas tree plantations at isolated locations in the Region. |

# Other Insects, Diseases and Damage

## Quebec Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Aspen serpentine leafminer *Phyllocnistis populiella* (Cham.) | Trembling aspen Balsam poplar | Along the Matane River between Saint René and the Matane River bridge | Light defoliation over 10 000 ha. |
| | | Along the Matane River between Routhierville and Saint Alexis de Matapédia | Light defoliation over 18 000 ha. |
| | | North of Lake Matapedia between Sayabec and Saint Tharcisus | Light defoliation over 4 400 ha. |
| | | Between Matapédia and New Richmond along the periphery of Highway 132 | Several points of moderate intensity. |
| | | Basins of Outardes, Manicouagan and Toulnustouc rivers. | Reduced intensity in same areas infested in 1985. |
| Beech bark disease *Nectria coccinea* var. *faginata* Lohm., Wats. & Ayers | Beech | West of Lake Memphremagog (Eastern Townships) | 18 new sites, including one severe infestation 2 km southeast of Bolton-Sud. |
| | | Lower Saint-Maurice (Trois Rivières) | Several sites in the southern part of this area. Heavy incidence of disease 4.4 km northwest of Saint-Gérard des Laurentides |
| | | Eastern Townships | Disease has progressed over this area and includes one moderate infestation 5 km SW of Saint Camille. |
| Birch casebearer *Coleophera serratella* (L.) | White birch | Areas of central Quebec, primarily Portneuf, Charlevoix, Lower Saint Maurice, La Tuque and Saguenay | Several small areas where trees are moderately to severely affected. |
| Birch leafminer *Fenusa pusilla* (Lep.) | White birch | Rollet, Beauchastel and Roulier (Abitibi-Témiscamingue) | Light to moderate defoliation. |
| | | 6 km south of Senneterre (Abitibi-Témiscaminque) | |
| Blowdown | Fir and spruce | West of Saint Donat (Montreal) | Covers an area of 91 ha. |
| | Balsam fir | 5 km south of Lake Bellefontaine (Rimouski Reserve) | Affects 78 ha. |

## Quebec Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Dutch elm disease *Ceratocystis ulmi* (Buism.) C. Moreau | White elm | Southwest of Saint Joseph de Clericy | Mortality of up to 100% of trees near the Kinojévis River (Abitibi-Témiscaminque) |
| | | 9 km north of St-Méthode (Saguenay/ Lake Saint Jean) | Disease present along the Ticouapé River. New mention. |
| | | 7 km south of Lake Deschênes (Charlevoix) | Extension of the disease along the Noire River. Mortality present. |
| Fall cankerworm *Alsophila pometaria* (Harr.) | Silver maple Manitoba maple | Assomption River between Guilbault and L'Epiphanie (Berthierville) | Light-to-severe defoliation over small areas. |
| Fall webworm *Hyphantria cunea* (Drury) | White ash White elm Trembling aspen | Southwest of Terrebonne Highway 125 (Montreal) | More than 1300 nests counted over 2.1 km. |
| | White ash | South of Joliette, Highway 131 (Montreal) | Nests in 75% of trees over a 1-ha area. |
| Frost damage | Trembling aspen Ash | Eastern Townships, Montreal, and Quebec City regions | In the majority of sites, 100% of trees suffered frost damage with more than 25% of foliage affected: in several locations, more than 75% of the crown was damaged. |
| | Balsam fir Norway spruce | In vicinity of Roxton Falls, Granby, Eastman and Valcourt (Montreal) | An estimated 130 000 Christmas trees were affected with more than 25% of new shoots frozen. Several Norway spruce and plantations were also affected. |
| Hail damage | Black spruce | 9 km north of Lake Bouliane (North Shore) | Plantation of 6000 trees suffered moderate damage. |
| | Jack pine | 10 km south of Lake Castagnier (Abitibi-Témiscamingue) | 100% of trees suffered trunk damage in a seed orchard. |
| Ink spot *Ciborinia whetzelii* (Seaver) Seaver | Trembling aspen | 1.5 km southeast of Rapide Danseur | Area most affected in the Abitibi region. Moderate infestation. |
| | | 1.3 km north of Lake du Goudron, the north boundary of the Laurentides wild-life sanctuary | Moderate level. General decline of the disease through rest of the province. |

## Quebec Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Jack pine sawfly *Neodiprion pratti banksianae* Roh. | Jack pine | Fort Coulonge, Île du Grand Calumet, and Chapeau | Light defoliation observed. |
| | | Trois Rivières Region | Continued presence of this insect along Highway 40 between Champlain and Cap de la Madeleine. |
| Larch casebearer *Coleophora laricella* (Hbn.) | Tamarack | South of Saint Georges (Beauce), Saint Prosper de Dorchester, and southwest of Bromont | Reduced populations as compared to 1985. |
| Large aspen tortrix *Choristoneura conflictanca* (Wlk.) | Trembling aspen | North Shore Region | Severe defoliation of 9500 ha over a total affected area of approximately 13 000 ha between Portneuf and Sainte Marguerite river basins. |
| Maple leafcutter *Paraclemensia acerifolia* (Fitch) | Sugar maple | South of Saint Hyacinthe and Drummondville | A total of 34 ha moderately defoliated, primarily near Roxton Falls and Saint Valérien. |
| Needle blight *Rhizosphaera pini* (Cda.) Maubl. | Balsam fir | 3 km south of Weedon (Eastern Townships) | Significant level of the disease found in a Christmas tree plantation. |
| Needle rusts *Uredimopsis* sp. *Melampsora abieti-capraearum* Tub. | Balsam fir | Eastern Townships and Quebec City region | Several Christmas tree plantations 75 to 100% affected at levels varying from trace to severe. |
| Oak leafshredder *Croesia semipurpurana* (Kft.) | Red oak | Beaupré | Moderate defoliation. |
| | | Orleans Island | Light defoliation. |
| Orangehumped mapleworm *Summerista leucitys* Francl. | Sugar maple | Saint Basile (Portneuf) and East Broughton (Beauce) areas | Only 5 to 10% defoliation in stands that were severely affected in 1985. An egg parasite, *Telenomus* sp., present in 90% of larvae, apparently caused this population decline. |
| Pitch mass borer *Synanthedon pini* (Kell.) | White pine | South of Farnham Centre (Montreal) | Present on 18% of pine trees in a stand. |
| Redheaded pine sawfly *Neodiprion lecontei* (Fitch) | Red pine | Outaouais Region | Light to moderate defoliation in 7 to 198 plantations visited. |
| Red pine sawfly *Neodiprion nanulus nanulus* Schedl. | Jack pine Red pine | Île du Grand Calumet, Vinton, Chapeau, and Waltham | Present in several plantations. |
| | | Saint Antoine-Abbé (Franklin) | Reduced population in the pitch pine ecological reserve. |
| Root rot *Cylindrocladium floridanum* Sobers & Seymour | Black, red, and white spruce | Provincial forest nurseries in Berthierville, Duchesnay, Grandes Piles, Normandin, and Sainte Luce | Between 1 and 15% of seedlings affected in certain lots under production. In Duchesnay and Sainte Luce, damage appeared after transplanting; 36% of 4.3 million red spruce and 20% of 30 million black spruce were affected. |

## Quebec Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Saddled prominent *Heterocampa guttivitta* (Wlk.) | Basswood | Southwest of Wotton (Eastern Townships) | Increased populations; light damage observed. |
| Shoot blight *Pollaccia radiosa* (Lib.) Bald. & Cif. | Trembling aspen | Throughout Quebec | Much more noticeable in 1986 because cool and damp spring conditions favored its development; particularly heavy in the Charlevoix area. |
| Sirococcus shoot blight *Siroccocus strobilinus* (Desm.) Petr. | Jack pine | Grandes Pines provincial forest nursery (Trois Rivières) | Approximately 7% of 1.3 million container seedlings infested. |
| Spruce budmoth *Zeiraphera canadensis* Mut. & Free. | White spruce | Gaspé - Lower St. Lawrence Region | Of 51 plantations visited, populations were moderate (2 to 8 larvae per branch) in 8 and high (more than 8 larvae per branch) in 2. These plantations are located in Saint Jean de Matapédia and north of the Josué lakes. Also reported in Quebec City, Eastern Townships, Montreal, Outaouais, and North Shore regions. |
| Spruce spider mite *Oligonychus ununguis* (Jac.) | Tamarack | North of Lake La Ferme (Gaspé) | Plantation of 300 000 trees, of which 39% are more than 25% infested. |
| | | 5 km north of Lake Paradis (Gaspé) | New infestation; a plantation of more than 100 000 trees, of which 56% are more than 25% affected. |
| Warren's root collar weevil *Hylobius warreni* Wood | Jack pine | Baie Trinité (Saguenay/Lake Saint Jean) | 50% of trees infested in a plantation of 35 000 seedlings. |
| White pine blister rust *Cronartium ribicola* J.C. Fisch. | White pine | Gaspé/Lower St. Lawrence | Found at trace levels in a 3000-tree plantation of 10-year old pines 7.5 km south ot Saint Anaclet, and light infestation in the natural forest 5 km away at Lake Fronsac (Gaspé). |
| | | North Shore | New infestation at trace levels 2 km southwest of Saint Anne de Portneuf. |
| | | | This pathogen is found at levels varying from trace to severe wherever there are white pine trees. |
| Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.) | Black spruce | La Vérendrye Reserve along Highway 117 | Moderate defoliation. |
| | White spruce | Vinton (Outaouais) | Plantation of 5000 trees of which 39% are 59% infested. |

# Other Insects, Diseases and Damage

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Alder flea beetle *Altica ambiens alni* Harr. | Alder | Northern, North Central and Northwestern regions | Occasional roadside bushes showing 75-100% defoliation throughout all regions. |
| American aspen beetle *Gonioctena americana* (Schaef.) | Trembling aspen | Sudbury District | Regeneration on a 5-ha area was defoliated in the 60-80% range in Hallam Township. |
| | | Geraldton, Terrace Bay and Wawa districts | Increasing populations at several locations. |
| Anthracnose *Apiognomonia venata* (Sacc. & Speg.) Hohnel | Sycamore | Simcoe District | Responsible for 20% branch mortality on ornamental trees in the town of Delhi. |
| *Aureobasidium apocryptum* (Ell. & Ev. ) Hermanides-Nijhof | Sugar maple Ashes | Eastern Region | Foliar damage was widespread and severe on roadside, open grown, fencerow and fringe trees with foliar damage ranging from 5 to 100% and averaging 35% on groups of trees in some areas. |
| *Discula campestris* (Pass.) v.Arx | Sugar maple Red maple | Algonquin Region | Severe foliar damage occurred in Minden and Parry sound districts. |
| *Discula umbrinella* (Berk. & Br.) Sutt. | Sugar maple | Northeastern and Southwestern regions | Light infections causing less than 20% foliar damage were observed at one location in each of Aylmer and Wingham districts and at numerous locations in the southern part of Sault Ste. Marie and Blind River districts. |
| *Gnomonia leptostyla* (Fr.) Ces. & de Not. | Butternut | Lindsay and Minden districts | Medium-to-heavy foliar infections, often causing 100% foliar damage were observed on single trees and groups of trees. |
| Armillaria root rot *Armillaria mellea* (Vahl:Fr.) Kummer | Jack pine Red pine | Northern Ontario and Algonquin District | Widespread at low infection rates (<5%) on young pines. |
| Ash yellows | White ash | Owen Sound District | Light damage was recorded in a 2-ha plantation in Sydenham Township. |
| Aspen leafblotch miner *Phyllonorycter ontario* (Free.) | Trembling aspen | Northwestern and North Central regions | Severe foliage leafmining was evident throughout much of this area. |
| | | Northern Region | Sporadic areas of high incidence occurred in the southern Cochrane District, central Kapuskasing District, and along Hwy. 631 of the Hearst District. Light infestations were evident through the remainder of the region. |
| Balsam poplar leafblotch miner *Phyllonorycter nipigon* (Free.) | Balsam poplar | Thunder Bay, Temagami, Sioux Lookout, and Ignace districts | Commonly found in high numbers. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Basswood looper *Erannis tiliaria* (Harr.) | Deciduous species | Northeastern Region | Moderate-to-severe defoliation on 12 ha in Howland and Sheguiandah townships on Manitoulin Island, Espanola District, and on 5 ha near Echo Bay, Sault Ste. Marie District. |
| | | North Central Region | Small heavy infestations near Barbara Lake and the town of Marathon, Terrace Bay District. |
| | | Parry Sound, Minden and Bracebridge districts | Low populations at several locations. |
| Balsam fir sawfly *Neodiprion abietis* complex | Balsam fir<br>White spruce<br>Black spruce | Northwestern Region | Moderate-to-severe defoliation of balsam fir occurred over 11 000 ha in the Pakwash-Ear Falls area, Red Lake District. Light infestations were reported in Sioux Lookout, Dryden, Kenora, and Fort Frances districts. |
| | | Algonquin Region | Approximately 1 300 ha of moderate-to-severe defoliation were recorded in Algonquin Park, Bancroft and Pembroke districts in scattered balsam fir stands. |
| Beech scale *Cryptococcus fagisuga* Lindinger | Beech | Central Region | Low numbers were collected at three locations. |
| Birch leafminer *Fenusa pusilla* (Lep.) | Grey birch<br>White birch | Eastern Region | Small areas (up to 5 ha) sustained moderate-to-severe defoliation in many areas. |
| | White birch | Central Region | Moderate-to-severe foliar damage occurred to small clumps of trees in Cambridge, Huronia, and Maple districts. |
| | White birch | Algonquin Region | Heavy damage (up to 80% defoliation) was reported in numerous 0.5-ha pockets in McKay Townships, Pembroke District. |
| | | Northern Ontario | Notable areas of damage to forest cover occurred over 200 ha in the Latchford-Haileybury area; in a 50-ha area of regeneration in Leguerrier Township, Wawa District; and in a 5-ha stand west of Clavet Township, Geraldton District. |
| Birch sawfly *Arge pectoralis* (Leach) | White birch | Temagami, Kirkland Lake and Minden districts | Low numbers causing low foliar damage (<25%) at numerous locations. |
| Black army cutworm *Actebia fennica* Tausch. | Herbaceous ground vegetation | Chapleau District | High numbers observed feeding in a 1985 prescribed burn site in Hill Township, Chapleau District. |
| | | Dryden District | Small numbers of larvae observed in seedbeds at the Dryden Forest Tree Nursery. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Bruce spanworm *Operophtera bruceata* (Hlst.) | Sugar maple<br>Red maple<br>Beech<br>Red oak<br>Trembling aspen | Algonquin Region | Moderate-to-severe defoliation was mapped within an area of 172 750 ha in Bancroft and Minden districts. Scattered pockets of similar damage occurred in adjacent areas of Bracebridge (3 100 ha), Algonquin Park (1 000 ha) and Pembroke (3 800 ha) districts. |
| | | Northeastern Region | Numerous areas of medium-to-heavy infestation recurred on Manitoulin, Cockburn, and St. Joseph islands and new infestations were mapped in the Sault Ste. Marie District. Affected area totalled 29 325 ha. |
| | | Eastern Region | Small heavy infestation of 20 ha was reported in Pakenham Township, Carleton Place District. |
| Cedar leafminers *Argyresthia aureo-argentella* Brower | Eastern white cedar | Southwestern Region | A 10-ha stand near Pike Bay on the Bruce Peninsula suffered 80–100% foliar damage. Low populations common throughout the region. |
| *A. canadensis* Free.<br>*A. thuiella* (Pack.) | | Espanola District | High populations present along southern shorelines of Manitoulin Island and in the Wikwemikong Indian Reserve. |
| *Pulicalvaria thujaella* (Kft.) | | Chapleau District | A 20-ha stand in Warren Township displayed 35% foliar damage. |
| Dutch elm disease *Ceratocystis ulmi* (Buism.) C. Moreau | Elm | Thunder Bay, Cornwall, and Pembroke districts | Noted at significant rates of infection in ornamentals and hedgerow trees. |
| Early birch leaf edgeminer *Messa nana* (Klug) | Grey birch | Napanee District | A heavy infestation occurred in Brighton Township. |
| | White birch | Sudbury and Bay districts | Light damage was reported at Ramsey Lake and in Hungel Township. |
| Eastern pine shoot borer *Eucosma gloriola* Heinr. | Jack pine<br>Red pine<br>White pine | Northern, Algonquin, and Eastern regions | Plantation surveys revealed a range of 1–5% leader mortality. |
| European alder leafminer *Fenusa dohrnii* (Tischb.) | European alder | Lindsay District | High levels of foliar damage noted at Orono Forest Station. |
| | Alder | Kirkland Lake and Temagami districts | Leafmining damage was common throughout both districts. |
| Eastern tent caterpillar *Malacosoma americanum* | Deciduous species | Eastern, Algonquin, and Central regions | Very high populations noted on several hardwood species. |
| | | Southwestern Region | Low populations infrequently noted. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| European pine sawfly *Neodiprion sertifer* (Geoff.) | Red pine Scots pine | Southern Ontario | Populations declined sharply in 1986. Moderate populations were noted in a 2-ha red pine plantation in Marlborough Township, Carleton Place District. |
| | | Espanola District | Heavy defoliation occurred in a small 2-m Scots pine plantation in Gordon Township, Manitoulin Island, along with several light infestations in Billings, Allan, and Gordon townships. |
| European pine shoot moth *Rhyacionia buoliana* (D. & S.) | Red pine Scots pine | Aylmer, Simcoe and Cambridge districts | High numbers of young plantation trees attacked at numerous locations. Shoot damage low in most cases (1 or 2 per tree). |
| Eutypella canker *Eutypella parasitica* Davidson & Lorenz | Sugar maple | Central Region, Tweed, Napanee and Brockville districts | Commonly found at low levels of incidence (<5%) in mature stands. |
| Fall cankerworm *Alsophila pometaria* (Harr.) | Mountain maple White elm | Northwestern Region | Overall decline in numbers with only occasional trees sustaining 30-40% defoliation in the towns of Dryden, Sioux Lookout, and Ignace. |
| | | Thunder Bay District | Westfort area of the city of Thunder Bay revealed 10-40% defoliation of occasional shade trees. |
| Fall webworm *Hyphantria cunea* (Drury) | Deciduous | Eastern Region | Small pockets of medium and heavy defoliation occurred in Lancaster, Charlottenburgh, Osnabruck, and East Hawkesbury townships, Cornwall District. Lowland areas of black ash in Fitzroy and Ramsay townships and roadside white elm in Bathurst Township, Carleton Place District, all contained heavy infestations. |
| | | Algonquin Region | High populations on roadside black ash and cherry trees in Bruton Township, Parry Sound District, caused 75% defoliation. |
| | | Central Region | A range of 30-60% defoliation was recorded in Otonabee and Belmont townships, Lindsay District and in northeastern Huronia District. |
| | | Southwestern Region | General decline in population numbers. |
| | | Northern Region | Completely defoliated areas of black ash, red maple and white elm occurred over 2-ha areas along Hwy. 17 between Sturgeon Falls and North Bay, North Bay District. |
| Fomes root rot *Heterobasidion annosum* (Fr.) Bref. | Red pine | Cornwall District | Four new pockets of dead and dying trees found in Clarence Township. |
| | | Simcoe District | Small 0.5-ha pocket detected in South Walsingham Township. |
| Frost damage | Conifers Hardwoods | Province wide | Widespread foliar damage at various levels (5-100%) primarily on white spruce, balsam fir, and trembling aspen. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Globose gall rust *Gymnosporangium globosum* Farlow | Juniper | Southwestern and Central regions and Niagara, Tweed, and Napanee districts | Widespread infection at varying levels. |
| Gray willow leaf beetle *Pyrrhalta decora decora* (Say) | Willow | North Central and Northwestern regions | Heavy browning of scattered bushes observed along major highways throughout much of the area. |
| Greenstriped mapleworm *Dryocampa rubicunda rubicunda* (Fabr.) | Maple | Espanola District | Complete defoliation to many understory trees in Tennyson and Boon townships. |
| Heat stress | Jack pine | Chapleau District | Approximately 50 000 bare-root trees were lost in a recently planted 40-ha area in Oates Township. |
| Hypoxylon canker *Hypoxylon mammatum* (Wahl.) J.H. Miller | Trembling aspen | Province wide | Low levels of infection throughout. |
| Imported willow leaf beetle *Plagiodera versicolora* (Laich.) | Willow | Eastern Region | Heavy infestations caused up to 80% foliar damage. |
| Ink spot *Ciborina whetzelii* (Seaver) Seaver | Trembling aspen | Timmins, Kirkland Lake, Sudbury, Espanola, Algonquin Park, Pembroke, Thunder Bay, and Atikokan districts | Widespread infections noted at varying levels of foliar damage. |
| Introduced pine sawfly *Diprion similis* (Htg.) | White pine | North Central, Central, Eastern, and Southwestern regions | Observed at a few plantations at reduced levels from 1985, light damage in all cases. |
| Jack pine sawflies *Neodiprion pratti banksianae* Roh. | Jack pine | Chapleau, Gogama, Timms, Sudbury, and Geraldton districts | Light defoliation (<10%) occurred at several locations. |
| *Neodiprion pratti paradoxicus* Ross | Jack pine | Algonquin Region | Small stands sustained defoliation in the 25% range in a 7 500-ha area between Barry's Bay and Pembroke; in the Petawawa-Rolphton area and in Radcliffe Township, Pembroke District. Up to 40% defoliation occurred in Chandos, Methuen, and Herschel townships, Bancroft District. |
| | | Eastern Region | High populations caused moderate-to-severe defoliation at several locations in the Brockville District and at single points in the Tweed and Carleton Place districts. |
| Jack pine tip beetle *Conophthorus banksianae* McPherson | Jack pine | Northern Region | Occurred at varying but generally low numbers in Invergarry and Jack townships, Gogama District, and in Dalmas, Arbutus, Peters, and Gilliland townships, Chapleau District. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Larch casebearer *Coleophora laricella* (Hbn.) | Tamarack European larch | North Central, Northern, Algonquin, and Southwestern regions | Low populations and light defoliation reported at widely spread locations. |
| | | Central and Eastern regions | A few pockets of moderate (25–75%) foliar damage persisted in 1986. |
| Larch needle cast *Meria laricis* Vuill. | European larch | Lindsay District | A heavy infection in the Orono Forest Station represents the first record of this disease in a tree nursery in eastern Canada. |
| | | Brockville District | Light damage was observed in a plantation of 3-m trees in rear of Yonge and Escott Township. |
| Larch sawfly *Pristophora erichsonii* (Htg.) | Larch | Northern Ontario | Low levels of damage noted at numerous locations. |
| | | Southern Ontario | Light damage (<10%) infrequently reported. |
| Larch-poplar rust *Melampsora medusae* Thum. | Trembling aspen Hybrid poplar | Brockville and Cornwall districts | Observations disclosed moderate-to-severe infections in natural stands in East Hawkesbury Township and on nursery stock in the G. Howard Ferguson Forestry Station, Oxford on Rideau Township. |
| Large aspen tortrix *Choristoneura conflictana* (Wlk.) | Trembling aspen | North Central, Northern, and Northeastern regions | Moderate-to-severe defoliation was mapped across 620 899 ha in 1986. Some or all of the following insects; the aspen twoleaf tier, *Enargia decolor* (Wlk.), the aspen leafroller, *Pseudexentera oregonana* Wlshm., Bruce spanworm, and forest tent caterpillar were occasionally found in conjunction with the large aspen tortrix. |
| Leaf blight *Septoria betulae* Pass. | White birch | Algonquin Region | The heaviest damage, affecting more than 75% of the foliage, occurred in stands across the northern part of the region. |
| Leaf blotch *Guignardia aesculi* (Peck.) | Horse-chestnut | Southwestern Region | A high incidence and corresponding foliar damage of 30% was observed. |
| | | Lindsay District | Collected from one location in Hamilton Township. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Leaf spot diseases<br>*Asteroma caryae* (Peck) | Shagbark hickory | Southwestern Region | Foliar damage levels of single trees and groups of trees varied from 10% to 35%. |
| *Linospora tetraspora* G.E. Thompson<br>*Septoria musiva* Peck<br>*Septoria populicola* Peck | Balsam poplar | Eastern and Algonquin regions | Moderate-to-severe foliar damage and premature defoliation was observed throughout the entire stand component. |
| | | Central and Southwestern regions | Medium-to-heavy infections of *S. populicola* were recorded wherever the host occurred. |
| | | Chapleau, Gogama, and Thunder Bay districts | Observations disclosed severe infections of *L. tetraspora* in many stands. |
| *Marssonina juglandis* (Lib.) Magnus | Black walnut | Southwestern and Central regions | Widespread foliar damage caused premature leaf drop. |
| | Butternut | Cornwall District | Heavy infection level at a single location, Lancaster Township. |
| *Mycosphaerella effigurata* (Schwein.) House | Ashes | Eastern Region | This disease was detected causing foliar infections averaging 20% to 40% in conjunction with *D. umbrinella*. |
| | Black ash | North Central Region | Widespread moderate-to-severe damage was recorded. |
| Linden wart gall midge<br>*Cecidomyia verrucicola* O.S. | Basswood | Wingham District | High numbers of galls infesting 60% of all woodlot trees examined, McKillop Township. |
| Maple leafcutter<br>*Paraclemensia acerifoliella* (Fitch.) | Sugar maple | Algonquin Region | Populations continued to decline. Areas of medium and heavy infestations occurred in Laxton Township, Minden District (75% defoliation on 8 ha); in Limerick Township, Bancroft District (30% defoliation on 40 ha); and in Wilberforce Township, Pembroke District (30% defoliation on 30 ha). |
| | | Eastern Region | Small pockets (up to 1 ha) of moderate-to-severe defoliation occurred in South Canonto Township, Tweed District. |
| Maple trumpet skeletonizer<br>*Epinotia aceriella* (Clem.) | Sugar maple | Central, Algonquin and Southwestern regions | Generally populations were down from 1985 levels and foliar damage was low (<10%). |
| | | Napanee District | Defoliation on understory trees averaged 80% in two separate 5-ha woodlots, in Hallowell Township. |
| | | Aylmer District | A well-established infestation in J.E. Pearce Provincial Park persisted with 90% of the trees suffering 40% foliar damage. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Mountain-ash sawfly *Pristiphora geniculata* (Htg.) | Mountain ash | Northwestern Region | High populations scattered between Ear Falls and Pakwash Provincial Park with 75–100% defoliation. |
| | | North Central Region | Moderate defoliation ranging from 30 to 60% observed at Nym, French, Marion, and Clearwater West Lakes and along Highway 623 in the Atikokan District. Similar damage occurred along Highway 527, Thunder Bay District. |
| | | Owen Sound District | Completely defoliated trees found sporadically through Craigleith Provincial Park. |
| Needlecast *Davisomycella ampla* (Davis) Darker | Jack pine | North Central, Northwestern, and Algonquin regions | Average foliar infections of 5% to 25% were recorded at several areas ranging in size from 0.5 ha to 500 ha. |
| *Isthmiella crepidiformis* (Darker) Darker | Black spruce | Geraldton District | Heavy infections were noted on 2-m trees in McQuesten Township. |
| *Lophodermium seditiosum* Minter, Staley & Millar | Red pine | Pembroke District | Evaluation revealed 33% and 16% of 1-m trees were affected in Sebastopol and Westmeath townships, respectively. |
| *Lophodermium* sp. | Red pine | Huronia District | Average defoliation of 19% in a 5-ha area in Tiny Township. |
| | Red pine | Pembroke District | Caused light mortality of young trees in Horton Township. |
| | Red pine | North Bay District | Average defoliation of 25% in Gurd Township. |
| Needle blight *Kabatina thujae* A. Schneider & V. Arx | Red cedar | Napanee District | Branch and whole tree mortality was common along Highway 401. |
| *Lophophacidium dooksii* Corlett & R. Shoem. | White pine | Algonquin Park District | Scattered pockets of mature trees experienced 80% foliar famage in FitzGerald Township. |
| Needle droop | Red pine | Blind River District | Varying degrees of foliage droop on 82% of the trees in a 2-ha plantation in Villeneuve Township. Parkinson Township contained 10 ha with 32% of the trees also affected. Light damage to small numbers of trees in Vance Township. |
| Northern pine weevil *Pissodes approximatus* Hopk. | White pine<br>Red pine | Algonquin Region | Mew Lake Camp Ground in Canisbay Township, Algonquin Park District contained a small area of 1-m red pine with 80% affected and 40% mortality. |
| | | Southern Region | A 1-ha area in Windham Township, Simcoe District, revealed 12% of 2-m white pine trees attacked with 6% mortality. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Oak leaf shredder *Croesia semipurpurana* (Kft.) | Red oak | Central and Southwestern regions | Low populations causing insignificant (<5%) foliar damage, at widespread locations. |
| | | Minden and Tweed districts | A few pockets of light defoliation reported. |
| Oak skeletonizer *Bucculatrix ainsliella* Murt. | Oak | Southwestern Region | Foliar damage of 20% occurred in Townsend Township, Simcoe District. Damage ranged up to 50% in Bayham, N. Dorchester, and Lobo townships, Aylmer District. |
| | | Central Region | Defoliation was generally less than 10%. Average of 30% foliar damage in N. Grimsby Township, Niagara District. |
| Oakworms<br>Orangestriped oakworm *Anisota senatoria* (J.E. Smith) | Bur oak | Aylmer and Chatham districts | Moderate-to-severe defoliation occurred on numerous scattered individuals. |
| Shorthorned oakworm *Anisota finlaysoni* Riotte | Bur oak<br>White oak | Cambridge district | Moderate-to-severe defoliation at two locations on open grown trees. |
| Oystershell scale *Lepidosaphes ulmi* (Linn.) | Beech | Cornwall District | As high as 90% defoliation occurred over 0.5 ha in Lancaster Township. |
| | | Carleton Place District | Approximately 50% defoliation on 10 ha of 10-m trees. |
| Orange spruce needleminer *Pulicalvaria piceaella* (Kft.) | White spruce and Norway spruce | Southwestern Region | Commonly found in most hedgerows examined with damage levels as high as 5%. |
| | White spruce | Huronia District | Young plantation trees displayed trace damage in West Gwillimbury Township. |
| Pine bud moth *Exoteleia dodecella* (Linn.) | Scots pine | Espanola District | Approximately 30-40% of the foliage was damaged in a 2-ha area in Dawson Township. |
| Pine false webworm *Acantholyda erythrocephala* (L.) | Red pine<br>White pine | Lindsay District | Highest populations occurred in Harvey Township where 3-m red pine were 90% defoliated and 2-m red pine averaged 25% defoliation over 6 ha in Stanhope Township. |
| | Swiss stone pine | Thunder Bay | Two collections made within the city represent a new distribution record for this introduced insect. |
| Pinegall weevil *Podapion gallicola* Riley | Red pine | Algonquin and Central regions | This insect continues to cause branch and whole tree mortality near Arnprior, Pembroke District, and the Nothumberland County Forest. Lindsay District. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Pine needle rust *Coleosporium asterum* (Dietel) Sydow | Jack pine Red pine | Northern, Northwestern, Central, and Eastern regions | High incidence recorded but associated damage was light. |
| | | North Central Region | Assessments disclosed 15% foliar damage and infection levels of 76% and 55% respectively in Hardwick Township, Thunder Bay District, and Stirling Township, Nipigon District. |
| | | Wawa District | Foliar damage averaged 30% in the 50-ha area in Alanen Township. |
| Pine spittlebug *Aphrophora cribrata* (Walker) | Pine | Southern Ontario | Light twig mortality occurred on Scots pine in Wingham District and on white pine in Tweed District. |
| | | Northern Ontario | Varying population levels were reported at several locations. |
| Pine tortoise scale *Toumeyella parvicornis* (Ckll.) | Jack pine | Kirkland Lake District | Numerous small infestations with high numbers of insects. |
| | Scots pine | Espanola District | High numbers recorded in a 0.5-ha stand in Billings Township. |
| Pitch mass borer *Synanthedon pini* (Kell.) | White pine | Maple District | Low numbers recorded on seed orchard trees in Albion Township. |
| | | Tweed District | Assessment disclosed 9% of 8-m trees in Hungerford Township were affected. |
| | White spruce | Huronia and Carleton Place districts | Low numbers were collected in two areas. |
| Poplar flea beetle *Altica populi* Brown | Balsam poplar | Algonquin Region | Defoliation ranged upwards to 50% in the southern part of Bancroft and Pembroke districts. |
| | | Northeastern Region | Severe browning occurred in the north portion of Espanola and Sudbury districts. |
| Porcupine damage | Red pine White pine | Brockville, Carleton Place and Tweed districts | Varying rates (1-38%) of top kill recorded on plantation trees. |
| Redheaded jack pine sawfly *Neodiprion virginiana* complex | Jack pine | Northern, North Central and Northwestern regions | Light defoliation of less than 10% recorded at a number of locations. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Redheaded pine sawfly *Neodiprion lecontei* (Fitch) | Red pine | Northeastern Region | Low populations were reported in North Bay, Espanola, and Blind River districts. |
| | Red pine<br>White pine | Algonquin and Eastern regions | Increased populations caused moderate-to-severe defoliation at numerous locations in Bracebridge, Minden, Tweed, Napanee, Carleton Place, and Brockville districts. |
| | | Central and Southwestern regions | High populations were recorded in Flos Township, Huronia Districts, and in Arran Township, Owen Sound District. |
| Red pine cone beetle *Conophthorus resinosae* Hopk. | Red pine<br>White pine | Temagami District | Very high numbers occurred in stands on islands and along the shoreline of Lake Temagami. |
| Red pine sawfly *Neodiprion nanulus nanulus* Schedl. | Red pine<br>Jack pine | Northwestern and North Central regions | Populations continue to decline. |
| | | Northeastern Region | High populations persisted in the Lake Temagami area, Temagami District. |
| | | Algonquin Region | Medium infestations occurred in several areas in the Pembroke District and at one location in the Bancroft District. |
| Salt damage | Red pine<br>White pine<br>White spruce<br>Jack pine | Eastern, Southwestern, Algonquin, Central, Northeastern, and North Central regions | Severely affected trees detected along major highways and heavily travelled routes. |
| Saratoga spittlebug *Aphrophora saratogensis* (Fitch) | Red pine | Pembroke District | Increased branch and tree mortality was evident in Hagarty, Fraser, and Ross townships. |
| | Sweetfern | Cochrane District | Small number of nymphs collected. |
| Satin moth *Leucoma salicis* (Linn.) | Lombardy poplar<br>Silver poplar | Eastern Region | Trees in East Hawkesbury Township, Cornwall District, and in Hallowell and Sophiasburgh townships and the city of Belleville, Napanee District, sustained moderate-to-severe defoliation. |
| Sawyer beetles *Monochamus scutellatus* (Say) & *M. mutator* Lec. | Jack pine<br>Black spruce | Gogama District | Approximately 10 ha of 15-m semi-mature jack pine beside the Ostrim debarking mill was severely attacked. |
| | | Red Lake District | Surveys revealed that 86% jof the 12.5-m jack pine and 22% of the 14-m black spruce were attacked in the Corallen Lake area. |
| Scorch | Sugar maple | Southwestern Region | This was a common occurrence especially in the Owen Sound District. |
| | | Simcoe District | It occasionally caused 15% defoliation on mature open grown trees. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Shoot blight *Sirococcus conigenus* (DC.) P. Cannon & Minter | Red pine | Sioux Lookout District | Low infection levels were recorded in Jordan and Echo townships. |
| Shoot blight *Venturia macularis* (Fr.) E. Muller & v.Arx | Trembling aspen | Northern and Northeastern regions | Leader mortality averaged 7% at 18 locations. |
| | | Pembroke, Fort Frances and Dryden districts | Light damage was recorded. |
| Snow blight *Phacidium abietis* (Dearn.) J. Reid & Cain | Balsam fir | Gogama District | Heavy infections were recorded on 1 ha of regeneration in Garibaldi Township. |
| Solitary oak leafminer *Cameraria hamadryadella* (Clem.) | Bur oak | Southern Ontario | Small areas of heavy infestations were reported in Otonabee Township, Lindsay District, and in Townsend Township, Simcoe District. |
| Spiny ash sawfly *Eupareophora parca* (Cress.) | Black ash | Temagami and Kirkland Lake districts | Heavy defoliation noted in upper crowns at numerous locations. |
| Spruce cone rust *Chrysomyxa pirolata* (Korn.) Winter | Black spruce | Thunder Bay District | Light infections were observed in three plantations. |
| Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun. | White spruce Balsam fir | Northern Ontario | Medium numbers, often in association with spruce budworm, recorded at a few widespread locations. |
| Spruce needle rusts *Chrysomyxa ledi* (Alb. & Schwein.) de Bary and *C. ledicola* (Peck) Lagerh. | Spruce | Red Lake District | Previous high infections declined and subsequent assessments disclosed less than 25% foliar damage. |
| | | Fort Frances, Ignace and Sioux Lookout districts | Small isolated pockets of less than 20 ha experienced 40% to 100% foliar damage. |
| | | North Central Region | Assessments disclosed 1-30% foliar damage in small stands of 1-30 ha. |
| Sugar maple borer *Glycobius speciosus* (Say) | Sugar maple | Eastern Region | Examination of four stands in the Brockville, Napanee, and Carleton Place districts revealed damage ranging from 2-17%. |
| Swaine jack pine sawfly *Neodiprion swainei* Midd. | Jack pine | Temagami District | Light defoliation was observed at several points on Lake Temagami. |
| | | Kenora and North Bay districts | Small numbers of insects were collected. |
| Sweet fern blister rust *Cronartium comptoniae* Arthur | Jack pine | Northern Region | Stem cankers were found on 9.3% of 3-m jack pine covering 40 ha in Carew Township, Chapleau District. |
| Tea pot fungus *Rhizina undulata* Fr. | NA | Red Lake District | Found in a recent burn near Corallen Lake. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Tip blight *Sphaeropsis sapinea* (Fr.) Dyko & B. Sutton | Scots pine Austrian pine | Central Region | Heavy damage persisted in previously infected areas. |
| | | Southwestern Region | Increased damage was evident particularly in the Simcoe District. |
| | Red pine | Atikokan, North Bay, and Sudbury districts | Light foliar damage (< 10%) noted at single locations in each district. |
| Tornado and wind damage | Coniferous and Deciduous species | Minden and Bancroft districts | About 400 ha destroyed by tornado. |
| | | Chapleau and Gogama districts | Estimation disclosed 3 541 ha of blowdown at numerous locations. |
| | | Tweed District | Damage occurred to 40 ha of mature white pine in Clarendon Township. |
| | | Brockville District | Broken bhrances and the occasional windthrown trees were observed. |
| | Sugar maple | Carleton Place District | The area of blowdown totalled 64 ha in 8 sugar bushes in North Sherbrooke Township. |
| Twoleaf tier *Psilocorsis reflexella* Clem. | Trembling aspen Red oak White birch | Algonquin Region | Small, heavy infestations recorded from a number of areas in the Minden, Bracebridge, and Parry Sound districts. |
| Verticilium wilt *Verticilium dahliae* Kleb. *Verticilium* sp. | Sugar maple Green ash | Eastern Region | Damaging ornamental sugar maple at several locations in the Brockville and Napanee districts. |
| Verticilium albo-atrum Reinke & Berth. | | Southwestern Region | Present in a green ash plantation in Sullivan Township, Owen Sound District. |
| Walnut caterpillar *Datana integerrima* G.&R. | Black walnut | Southwestern Ontario | Occasionally encountered causing varying levels of foliar damage. |
| Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirat. | Jack pine | Northern Ontario | Control measures were carried out at Ontario Ministry of Natural Resources Tree Nurseries in Chapleau and Dryden districts. Elsewhere the number of trees affected averaged 8% at 20 locations in 11 districts. |
| White mold *Microstroma juglandis* (Bereng.) Sacc. | Shagbark hickory | Niagara District | Foliar damage of 40% was detected in Bertie Township. |

## Ontario Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| White pine blister rust *Cronartium ribicola* J.C. Fisch. | White pine | Algonquin Park, Blind River and Wawa districts | Evaluation revealed up to 6% mortality. |
| | | Algonquin, Northeastern, Northwestern and Eastern regions | Number of trees affected average 9% at 11 locations. |
| White pine weevil *Pissodes strobi* (Peck) | White pine | Northwestern, North Central, Northern and Northeastern regions | Increased damage was observed in all four northern regions. |
| | | Southern Ontario | Static populations causing an average 10% leader damage in most plantations. |
| Willow flea weevil *Rhynchaenus rufipes* (Lec.) | Willow | Eastern Region | Heavy infestations throughout the Region with defoliation occasionally reaching 100%. |
| Willow leafminer *Micurapteryx salicifoliella* Cham. | Willow | North Central Region | Numbers declined to widely scattered populations |
| | | Northern Region | Pockets of severe leafmining at scattered locations. |
| Winter drying | Eastern white cedar | Chapleau and Gogama districts | Approximately 100 ha of damage occurred in the Chapleau District and another 50 ha in the Gogama District. |
| | Red pine | Lindsay District | Caused approximately 20% seedling mortality in two compartments. |
| | White pine<br>Red pine<br>White spruce | Sudbury, North Bay, and Pembroke districts | Small pockets of light damage were reported at a number of locations. |
| Woolly alder sawfly *Eriocampa ovata* (Linn.) | European alder | Lindsay District | Defoliation of 50% occurred at the Orono Forest Station. |
| | Alder | Thunder Bay District | Defoliation of 100% common in the city of Thunder Bay. |
| | | Dryden District | Total tree defoliation was routinely encountered. |
| Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.) | Spruce | North Central and Northeastern regions | High populations routinely noted causing severe defoliation of plantation and roadside trees. |
| | | Pembroke and Bracebridge districts | Severe defoliation (80% on average reported at several locations. |

# Other Insects, Diseases and Damage

## Western and Northern Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Armillaria root rot<br>*Armillaria mellea* (Vahl ex Fr.) Kumm. | Pine<br>White spruce | Prairie provinces | Low but significant tree mortality occurred in certain natural regeneration and plantations. In Manitoba, tree mortality occurred in a white spruce plantation and continued in red pine plantations. |
| Atropellis canker<br>*Atropellis piniphila* (Weir) Lohman and Cash | Pine | Alberta | Canker infections reported in the Cypress Hills and in some areas of the foothills. Some mortality noted near Seebe (Kannanaskis). |
| Balsam fir sawfly<br>*Neodiprion abietis* (Harr.) | Balsam fir | Manitoba | Moderate to severe defoliation on about one section of land. |
| Birch leafminers<br>*Fenusa pusilla* (Lep.)<br>*Heterarthrus nemoratus* (Fall.)<br>*Profenusa thomsoni* (Konow) | Birch species | Prairie provinces | Light, moderate, and severe damage persisted in most major urban areas. Common throughout forest stands with severe damage in certain areas. |
| Chemical injury | Several species | Prairie provinces | Increased reports of mortality and injury to non target trees by chemicals, especially soil sterilants in urban areas. |
| Cytospora canker<br>*Cytospora chrysosperma* Pers. ex Fr. | Poplar<br>Mountain-ash | Alberta | Common on host trees in most urban areas. |
| Dwarf mistletoes<br>*Arceuthobium americanum* Nutt. ex Engelm.<br>*A. pusillum* Pk. | Lodgepole pine<br>Jack pine<br>Spruce | Prairie provinces | A perennial problem: causes severe witches' broom, stem deformation, reduced growth, and tree mortality, especially in jack pine stands. |
| Early aspen leafcurler<br>*Pseudexentera oregonana* (Wlshm.) | Aspen | Manitoba | Light-to-moderate damage occurred in Birds Hill Provincial Park and Spruce Woods Provincial Forest. |
| Eastern black-headed budworm<br>*Acleris variana* (Fern.) | Fir<br>Spruce | Prairie provinces | Moderate-to-severe defoliation occurred near Pisew Falls, Manitoba and in Central Saskatchewan. Light defoliation in Banff, Jasper, and Watertown Lakes National Parks. |
| European spruce sawfly<br>*Gilpinia hercyniae* (Htg.) | Spruce | Manitoba | One larva found at Hadashville, southeastern Manitoba. |
| Fall cankerworm<br>*Alsophila pometaria* (Harr.) | Manitoba maple<br>White elm<br>Green ash | Prairie provinces | A major defoliator of host species in most large urban centers in Saskatchewan. Low populations occurred in Medicine Hat and Lethbridge, Alberta. |
| Fire blight<br>*Erwinia amylovora* (Burr.) Winslow et al. | Apple<br>Cotoneaster<br>Crabapple<br>Hawthorn<br>Mountain-ash | Alberta<br>Saskatchewan | Common infections on mountain-ash and other hosts in both provinces, especially in urban areas. |
| Frost damage | Many species | Prairie provinces<br>Northwest Territories | Occasional damage to new shoots especially white spruce. |

## Western and Northern Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Horntail<br>*Sirex cyaneus* F. | Balsam fir | Manitoba | A few trees had moderate populations in Northwest Angle Provincial Forest. |
| Hypoxylon canker<br>*Hypoxylon mammatum* (Wahl.) J.H. Miller | Aspen | Prairie provinces | Canker infections occurred in most native stands examined in the region. |
| Introduced pine sawfly<br>*Diprion similis* (Htg.) | Scots pine | Manitoba | First detected in 1983 near Winnipeg; the distribution remains unchanged. |
| Jack pine resin midge<br>*Cecidomyia resinicola* (O.S.) | Jack pine | Manitoba | New shoots killed, causing moderate damage in localized areas near Grand Rapids. |
| Larch casebearer<br>*Coleophora laricella* (Hbn.) | Larch | Manitoba | A few larvae found near South Junction. |
| Larch sawfly<br>*Pristiphora erichsonii* (Htg.) | Larch | Prairie provinces<br>Northwest Territories | Light defoliation occurred in two areas in southeastern Manitoba. Populations were endemic in other areas. |
| Large aspen tortrix<br>*Choristoneura conflictana* (Wlk.) | Aspen | Prairie provinces | Light and moderate defoliation in small areas in southern Alberta, southeast Saskatchewan, and southern Manitoba. |
| Lodgepole pine terminal weevil<br>*Pissodes terminalis* Hopping | Pine | Prairie provinces | Low incidence in most plantations surveyed. |
| Mountain-ash sawfly<br>*Pristiphora geniculata* (Htg.) | Mountain-ash | Manitoba | Six trees suffered light damage near Falcon Lake, Manitoba/Ontario border. |
| Northern pitch twig moth<br>*Petrova albicapitana* (Bsk.)<br>*P. metallica* (Bsk.) | Jack pine<br>Lodgepole pine | Prairie provinces | Trace in Manitoba, common in jack pine stands in Saskatchewan, and common in native pine stands in Alberta. |
| Pine root collar weevil<br>*Hylobius* spp. | Pine<br>Spruce | Manitoba<br>Alberta | Occurred in low numbers in pine plantations and regeneration. |
| Porcupine damage | Pine | Alberta<br>Manitoba | Jack and red pine damaged in two areas in Manitoba. Lodgepole pines were injured in two areas in Banff National Park. |
| Rabbit damage | Jack pine | Northwest Territories | Occasional tree mortality along roads. |
| Scleroderris canker<br>*Ascocalyx abietina* (Lagerb.) Schläpfer-Bernhard | Lodgepole pine | Alberta | Found only in known areas of Jasper National Park. |
| Silver leaf<br>*Stereum purpureum* (Pers. ex Fr.) Fr. (=*Chondrostereum purpureum*) | Mountain-ash<br>Apple<br>Cotoneaster<br>Other species | Alberta<br>Saskatchewan | A general decline, but continues to be a common problem on older mature plants in many urban areas. A slight increase in infection occurred in Saskatchewan. |
| Spruce gall adelgids<br>*Adelges cooleyi* (Gill.)<br>*Pineus similis* (Gill.)<br>*P. pinifoliae* (Fitch) | Spruce<br>Pine | Prairie provinces<br>Northwest Territories | Damage light but common in several areas. Moderate-to-severe damage in one area in the Northwest Territories. |

## Western and Northern Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Spruce spider mite<br>*Oligonychus ununguis* (Jac.) | Spruce<br>Juniper<br>Cedar | Prairie provinces | Common on all hosts throughout the region, especially on mature and semimature trees in urban areas. |
| Two-year-cycle spruce budworm<br>*Choristoneura biennis* Free. | Alpine fir<br>Engelmann spruce | Alberta | Low populations and light damage in two areas in Banff National Park. |
| Western ash bark beetle<br>*Leperisinus* spp. | Green ash | Saskatchewan<br>Alberta | Still causing moderate-to-severe damage to ash trees on University of Saskatchewan grounds. Low populations common in southern areas of both provinces. |
| Western gall rust<br>*Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka | Lodgepole pine<br>Jack pine | Prairie provinces<br>Northwest Territories | Common at low levels in scattered young pine regeneration and plantations. |
| White pine weevil<br>*Pissodes strobi* (Peck) | Spruce<br>Pine | Prairie provinces | Spruce and pine leader mortality. Common on young trees in Manitoba, Saskatchewan and Alberta. |
| Willow leafminer<br>*Lynetia* sp. | Willow | Prairie provinces<br>Northwest Territories | Moderate-to-severe damage in several scattered areas in Saskatchewan and the Northwest Territories. |
| Winter drying | Several species | Prairie provinces | Foliage browning decreased especially on spruce, Scots pine, and cedars. |
| Yellowheaded spruce sawfly<br>*Pikonema alaskensis* (Roh.) | Spruce | Prairie provinces<br>Northwest Territories | Moderate-to-severe damage was common in several small areas. Light defoliation occurred in a few areas in the Northwest Territories. |

# Other Insects, Diseases and Damage

## Pacific and Yukon Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| An alder leafhopper *Oncopsis californica* Van Duzee | Red alder | Prince George region | 10% defoliation of upper crowns of all immature alder over 2 ha near Lynx Creek. |
| Alder leafminer *Lithocolletis* sp. | Red alder | Nelson region | Skeletonized 30% of the foliage on roadside trees for 5 km near Cascade Creek. |
| Ambermarked birch leafminer *Profenusa thomsoni* (Konow) | White birch<br>Trembling aspen | Prince George region | Expanded to Prince George city limits after being first collected in 1985. |
| Anthracnose *Gloeosporium* sp. | Dogwood | Vancouver region | Defoliation common and variable. |
| Aspen serpentine leafminer *Phyllocnistis populiella* Cham. | Trembling aspen<br>Black cottonwood | Nelson, Prince Rupert, Vancouver regions | Light foliage damage near Boya Lake, Revelstoke and Nakusp. Moderate over 200 ha near Cheakamus Lake, and severe near Grand Forks. |
| Aspen skeletonizer *Phratora purpurea purpurea* Brown | Trembling aspen | Prince George region | Infested 5% of the foliage on most of the host. |
| Atropellis canker *Atropellis piniphila* (Weir) Lohman and Cash | Lodgepole pine | All regions | Widespread throughout host range. Mature pine near Salmon Arm with 1–4 cankers on 80% of the trees are typical. |
| A bacterial canker *Pseudomonas syringae* van Hall | Black cottonwood | Prince Rupert region | Small cankers killed current growth on several trees in a patch near Hazelton. |
| | Trembling aspen | Prince George region | A new host record; light infection on half the trees near Pineview. |
| Balsam twig aphid *Mindarus abietinus* Koch | Alpine fir<br>Grand fir | Kamloops, Nelson regions | All new foliage infested over 10 ha near McGillivray Creek and scattered patches of severe infestation south of Creston. |
| Bark beetle *Pityogenes plagiatus knechteli* Swaine | Lodgepole pine | Yukon Territory | Common secondary in recently killed trees throughout the Territory. |
| Birth leafminer *Lyonetia saliciella* Bsk. | White birch | Kamloops region | Infestations over 3100 ha declined to trace. |
| | | Nelson region | Infestations light to moderate near Revelstoke and Golden, severe near Kaslo. |
| | | Prince George region | Infestation greatly reduced. |
| Black stain root disease *Ceratocystis wageneri* (Kend.) Goheen and Cobb | Douglas-fir | Vancouver, Kamloops, Nelson regions | Common in many areas in the southern half of the province, causing patchy mortality. |
| Black willow leaf beetle *Pyrrhalta punctipennis* (Mann.) | Red alder<br>Willow<br>Black cottonwood | Prince Rupert, Kamloops, Vancouver regions | Lighter defoliation in 1986 in the Skeena, Kallum, and Kitimat valleys; elsewhere patchy. |

## Pacific and Yukon Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Brown felt blight *Herpotrichia juniperi* (Duby) Petr. | Alpine fir<br>White bark pine | Nelson, Prince Rupert, Vancouver regions | Common on regeneration and lower branches of larger trees. |
| Comandra blister rust *Cronartium comandrae* Peck | Lodgepole pine | Cariboo, Nelson, Prince Rupert regions | Prevalent in pine stands, particularly damaging in young stands and plantations. |
| Cooley spruce gall adelgid *Adelges cooleyi* (Gill.) | Engelmann spruce<br>White spruce<br>Sitka spruce<br>Douglas-fir | All regions | Common, including much of the current Douglas-fir foliage, and moderate gall damage to spruce in many seed orchards. |
| Cypress tip moth *Argyresthia* sp. | Ornamental cypress | Vancouver Island | Again common in Victoria and Pacific Rim National Park. |
| Deer browse | Lodgepole pine<br>Douglas-fir | Prince George, Vancouver regions | Light feeding to 17% of a young stand near Shesta Lake and light-to-moderate feeding common on Vancouver Island and the Gulf Islands. |
| Douglas-fir beetle *Dendroctonus pseudotsugae* Hopk. | Douglas-fir | All regions | Populations remain scattered and at low levels. |
| Douglas-fir cone moth *Barbara colfaxiana* (Kearfott) | Douglas-fir | Nelson region | Average 28% of the cones infested at three of five locations. |
| | | Vancouver Island | Average 4% of cones infested, a slight increase from 1985. |
| Douglas-fir cone scale midge *Contarinia washingtonensis* Johns. | Douglas-fir | Vancouver Island | Average of 5% of the cones at 1054 orchards were *intested.* |
| Douglas-fir gall midge *Contarinia oregonensis* Foote | Douglas-fir | Vancouver Island | Infested 21% (0-60%) of cones in four orchards; up from 1985. |
| Douglas-fir tussock moth *Orgyia pseudotsugata* (McD.) | Douglas-fir | Kamloops region | No defoliation occurred following the population collapse in 1984. Only endemic populations are forecast in 1987. |
| Drought damage | Douglas-fir<br>Western hemlock<br>Lodgepole pine | Kamloops, Nelson, Prince Rupert, Prince George and Vancouver regions | Dieback of older foliage and scattered mortality and branch dieback common along roadsides and in large openings. |

## Pacific and Yukon Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Dwarf mistletoes<br>*Arceuthobium americanum* Nutt. ex Engelm. | Lodgepole pine | All regions | A chronic pest throughout most of the host range causing mortality and growth loss. |
| *Arceuthobium douglasii* Engelm. | Douglas-fir | Kamloops, Nelson regions | Widespread in patches throughout the Interior host range, causing significant growth loss. |
| *Arceuthobium laricis* (Piper) St. John | Western larch | Nelson region | Common throughout the host range causing top-kill and growth loss. |
| *Arceuthobium tsugense* (Rosendahe) G.N. Jones | Western hemlock | Prince Rupert and Vancouver regions | Widespread in patches throughout the coastal host range causing significant growth loss. |
| Dwarf mistletoe hyperparasites<br>*Colletotrichum gloeosporioides* Penz. | Lodgepole pine dwarf mistletoe | Cariboo, Nelson, Prince George regions | Widespread and common on 20–70% of the host plants at 20 locations examined. |
| *Cylindrocarpon gillii* (D.E. Ellis) J.A. Muir | | Cariboo region | First record of this hyperparasite in dry belt stands. |
| *Wallrothiella arceuthobii* (Peck) Sacc. | | Prince Rupert region | 30% of the aerial shoots were infected at 5 locations examined. |
| An elm leafminer<br>*Agromyza* sp. (prob *aristata* Malloch) | Elm | Prince George region | New distribution record. Mined 25% of foliage in residential area. |
| Elytroderma disease<br>*Elytroderma deformans* (Weir) Darker | Ponderosa pine | Cariboo, Kamloops, Nelson regions | Light and moderate needle infection and brooming common throughout the host range. |
| European larch canker<br>*Lachnellula willkommii* (Hartig) Dennis | Western larch<br>Tamarack<br>Alpine larch | All regions | Surveys negative for 6th consecutive year. |
| European pine shoot moth<br>*Rhyacionia buoliana* (D.&S.) | Ornamental pines | Vancouver Island<br><br>Kamloops region | Minor damage to ornamental pines continues from Victoria to Courtenay.<br>Not captured in pheromone traps although ornamental pines were lightly infested. Damage not evident in native pines. |
| Fall webworm<br>*Hyphantria cunea* (Drury) | Deciduous trees | Kamloops, Nelson, Vancouver regions | Light in scattered pockets. |
| Fir coneworm<br>*Dioryctria abietivorella* (Grote) | Douglas-fir<br>White spruce | Prince George, Prince Rupert regions<br>Vancouver Island | Infested 5–10% of the cones at several widely distributed locations. |
| Frost damage | Western hemlock<br>Engelmann spruce<br>White spruce<br>Sitka spruce<br>Amabilis fir | All regions | Generally light damage, less than in 1985, except in pockets in the Nelson Region and the Heffley Creek seed orchard. |

## ific and Yukon Region

| cts, Disease, amage | Host(s) | Location | Remarks |
|---|---|---|---|
| delgids<br>*us* spp. | White spruce | Prince Rupert region | Galls severe at two locations but only on a few trees. |
| striped forest-looper<br>*nolophia imitata*<br>.) | Douglas-fir<br>Western | Nelson, Prince Rupert, Vancouver regions<br>regions | Endemic populations continue. |
| ck-willow foliar rust<br>*mpsora epitea*<br>m | Willow | Prince Rupert region | Early yellowing and leaf drop again common in Skeena, Kallum, and Kitimat valleys. |
| beetle<br>*ridens*<br>nnerheim) | White spruce | Prince George region | Lightly infested windthrow throughout the Bowron River drainage. |
| spruce cone rust<br>*somyxa pirolata*<br>. | White spruce | Prince George region | 3% of cones infected in the Bowron River Valley and near Fort Fraser. |
| budmoth<br>*aphera improbana*<br>.) | Western larch | Nelson and Kamloops regions | Infestations collapsed with only a few pockets of light larval activity persisting. |
| casebearer<br>*ophora laricella*<br>n.) | Western larch | Nelson regions | Decline to endemic level with small pockets of moderate defoliation remaining in east and west Kootenay. |
| sawfly<br>*iphora erichsonii*<br>.) | Western larch<br>Tamarack | Kamloops, Nelson, Vancouver regions<br>Yukon Territory | Populations at low endemic levels, except exotic larches again moderately defoliated in UBC Research Forest near Haney. |
| shoot moth<br>*resthia laricella* Kft. | Western larch | Nelson region | Killed 20% of the branch tips on roadside trees near Canal Flats. |
| aspen tortrix<br>*ristoneura conflictana*<br>.) | Trembling aspen | Yukon Territory<br>Prince George region | Slight increases with light defoliation in five locations and patchy between Fort St. John and Fort Nelson. |
| usts<br>*osporium asterum*<br>t.) Syd. | Lodgepole pine | Prince Rupert region | Light-to-moderate infection in patches near Telkwa, trace in other areas. |
| *ciniastrum epilobii*<br>. | Amabilis fir<br>Alpine fir | Cariboo,<br>Prince Rupert,<br>Vancouver regions | Generally light except severe infection of current growth in and north of the Nass Valley. |
| *accinii* (Wint.) Joerst. | Western hemlock | Queen Charlotte Islands | Low intensity on current growth. |
| *mpsora epitea* Thum. | Willow | Prince Rupert region | Discoloration and premature leaf drop on scattered shrubs throughout the southwestern portion of the region. |
| *ccidentalis* Jacks. | Black cottonwood | Prince Rupert region | Premature yellowing and leaf drop from saplings common in southwest portion of region. |
| | Douglas-fir | Cariboo and Vancouver regions | Moderate and severe foliar yellowing near Riske Creek and in plantations near Hagensborg. |
| *nedusae* Thum | Douglas-fir | Nelson region | Very light in young stands. |

## Pacific and Yukon Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Lodgepole pine beetle *Dendroctonus murrayanae* Hopk. | Lodgepole pine | Yukon Territory Cariboo, Nelson, Prince George, Prince Rupert regions | Yukon populations declined, but elsewhere common in stressed trees or trees attacked by mountain pine beetle. |
| Lodgepole pine terminal weevil *Pissodes terminalis* Hopping | Lodgepole pine | Cariboo, Prince George, Prince Rupert, Kamloops, Nelson regions | Common in regeneration and some thinned stands, averaging 10% with up to 30% current attack of leaders. High over-wintering brood mortality in some stands. |
| Lonchaeid flies *Lonchaea* sp. | Lodgepole pine | Nelson, Prince George, Prince Rupert regions | Predacious larvae common in mountain pine beetle and spruce weevil galleries. |
| Maple discoloration and dieback | Broadleaf maple | Vancouver Island | Moderate foliar browning on 20% of trees from Victoria to Port Alberni and Comox. Possibly a xylem bacterial infection. |
| Monterey pipe Ips *Ips mexicanus* (Hopkins) | Lodgepole pine | Nelson, Prince Rupert regions | Common secondary bark beetle following mountain pine beetle. |
| Needle blight *Didymascella thujina* (Durand) Maine | Western red cedar | Nelson, Vancouver regions | Severe infection of older foliage near Boundary Creek and light infections common in coastal areas. |
| *Leptomelaconium pinicola* (Berk. & Curt.) Hunt | Ponderosa pine | Nelson region | Infections declined to light levels near Elko. |
| *Meria laricis* Vuill. | Western larch | Nelson and Kamloops regions | Infections again only light. |
| Needle casts *Elytroderma deformans* (Weir) Darker. | Ponderosa pine | Cariboo, Kamloops, Nelson regions | Light and moderate needle infection and brooming common throughout the host-range. |
| *Hypodermella laricis* Tub. | Western larch | Nelson and Kamloops regions | Infections common but only light. |
| *Lirula macrospora* (Hartig) Darker | Sitka spruce White spruce | Prince Rupert region | Generally light, but up to 90% of 1985 foliage infected in young stands near Hazelton. |
| *Lophodermella concolor* (Dearn) Darker *L. montivaga* Petr. *Lophodermium* sp. | Lodgepole pine | All regions Yukon Territory | General decline to trace or light intensity in most areas but moderate near Kamloops. |
| *Phaeocryptopus gaeumannii* (Rohde) Petr. | Douglas-fir | Vancouver, Cariboo Nelson, Prince George regions | Light to moderate in three seed orchards, elsewhere light in natural stands and on seedlings. |
| *Rhabdocline* spp. | Douglas-fir | Kamloops, Nelson, Vancouver regions | Infections declined to light in young stands and seed orchards. |
| Northern spruce engraver *Ips perturbatus* (Eichh.) | White spruce | Prince George region | Decreased to about 1000 trees top-killed in the Torpy and Bowron valleys. |
| Oblique banded leafroller *Choristoneura rosaceana* (Harris) | Trembling aspen | Prince George region | 5% of foliage infested. |

## Pacific and Yukon Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Pacific willow leaf beetle *Pyrrhalta decora carbo* (LeC.) | Willow<br>Red alder | Nelson, Prince Rupert, Prince George regions | Common at low levels except severely skeletonized foliage near Prince George and from Cedarvale to Meziadin. |
| Phacidiella canker *Potebniamyces coniferarum* (Hahn) Smerlis | Western larch | Nelson region | Up to 20% of the branch tips on roadside regeneration killed near Moyie Lake. |
| Pine butterfly *Neophasia menapia* (F.&F.) | Douglas-fir | Vancouver Island | Adults more common than in recent years on the southern half of the Island. |
| Pine engraver *Ips pini* (Say) | Lodepole pine | All regions | Widespread, particularly associated with areas of decreasing mountain pine beetle and stressed trees. |
| Pine leaf adelgid *Pineus pinifoliae* (Fitch) | Sitka spruce<br>White spruce | Prince Rupert region | Trace to light, but increasing on 40% of saplings in plantations in the Kitimat, Skeena, and Nass valleys. |
| Pine needle scale *Chionaspis pinifoliae* (Fitch) | Lodgepole pine | Nelson region | Severe infestation of roadside trees near Hellroaring Creek. |
| Pine needle sheathminer *Zelleria haimbachi* Bsk. | Lodgepole pine | Kamloops, Nelson, Vancouver regions | Scattered severe infestations on new shoots on young trees. |
| Pitch module makers *Petrova albicapitana* (Bsk.)<br>*P. metallica* (Bsk.) | Lodgepole pine | All regions | Endemic populations in most areas. Light damage in plantations south of Burns Lake. |
| Poplar borer *Saperda calcarata* Say | Trembling aspen | Yukon Territory | 30 to 80% of saplings infested in stands near Mayo and Stewart Crossing. |
| Poplar and Willow borer *Cryptorhynchus lapathi* (L.) | Willow | Nelson and Prince Rupert regions | High numbers of shoots and stems killed. |
| Poplar shoot blight | Trembling aspen | Prince Rupert region | Severe defoliation again from Kitwanga to Cedarvale but patchy with light and moderate pockets. |
| *Venturia macularis* (Fr.) E. Mull & Arx | | Nelson and Prince George regions | Increased infections in the east and west-Kootenays but lighter infections elsewhere. |
| *V. populina* (Vuill.) Fabric. | Black cottonwood | Nelson, Prince Rupert, Vancouver regions | Generally light but some severe infections in the Skagit Valley. |
| Ragged spruce gall adelgid *Pineus similis* (Gill.) | Sitka spruce<br>White spruce | Prince Rupert region | Widely scattered, moderate galling in plantations. |
| Red band disease *Scirrhia pini* Funk & Parker | Western white pine<br>Lodgepole pine | Prince George, Prince Rupert, Nelson, Kamloops regions | Infection remained low in stands severely infected in 1984. |
| Red turpentine beetle *Dendroctonus valens* LeConte | Ponderose pine | Nelson region | Infested 5% of the fire-scorched trees near Skookumchuck and Canal Flats and western pine beetle infested stands near Fruitvale and Grand Forks. |

## Pacific and Yukon Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Salt damage | Conifers | Nelson and Prince Rupert regions | Scattered discoloration along roadsides near Cranbrook, Golden, Revelstoke, and Dease Lake. |
| Satin moth *Leucoma salicis* (L.) | Trembling aspen<br>Black cottonwood | Cariboo, Nelson, Kamloops regions and Vancouver Island | General decline with small patches of light defoliation. |
| Sawflies *Neodiprion* spp. | Lodgepole pine | Nelson, Kamloops, Vancouver regions | Most infestations collapsed or declined, but defoliation expanded to 400 ha near Creston. |
| | Western hemlock | Prince Rupert region | Severe defoliation again combined with the blackheaded budworm in same areas on the Queen Charlotte Islands. |
| A scarab beetle *Dichelonyx fulgida* LeConte | Douglas-fir | Nelson region | Up to half (avg. 10%) the new shoots on immature trees defoliated over 10 ha near Elko. |
| Secondary fungus *Leptosphaeria* sp. | Sitka alder | Prince George region | New host record of this "secondary" fungus. |
| Seedling weevil *Steremnius carinatus* (Boh.) | Douglas-fir<br>Western hemlock<br>Amabilis fir<br>Western red cedar<br>Sitka spruce<br>Grand fir | Vancouver Island | 20% of recently planted seedlings killed and 40% partially girdled near Cowichan Lake; common at low numbers elsewhere. Girdling and mortality in new plantations averaged 5% (0–12%) of the seedlings of several species. |
| Sequoia pitch moth *Synanthedon sequoiae* (Hy. Edwards) | Lodgepole pine | Vancouver region | Infested 6% of young trees at Mohokum Creek, elsewhere common but light. |
| Silverspotted tiger moth *Lophocampa argentata* (Pack) | Douglas-fir | Vancouver Island | Declined to a few widely scattered colonies. |
| Sirococcus tip blight *Sirococcus strobilinus* Preuss | Western hemlock | Vancouver region | Killed 10% of the shoots on 60% of the saplings over 16 ha near Haney. |
| Spruce aphid *Elatobium abietinum* (Wlk.) | Sitka spruce | Queen Charlotte Islands<br>Vancouver region | Populations declined because of cold winter temperatures with little damage except light feeding on 20% of the trees in a seed orchard near Nanaimo. |
| Spruce broom rust *Chrysomyxa arctostaphyli* Diet. | White spruce | All regions | Common within the host range, particularly northern British Columbia and the Yukon. |
| Spruce budmoths *Zeiraphera* spp. | Sitka spruce<br>White spruce | Prince George, Prince Rupert regions, Vancouver Island | Low to moderate on new growth in plantations in the Kitimat, Skeena, and Nass valleys and at Pacific Rim Park. |
| Spruce cone axis midge *Dasineura rachiphaga* Tripp | White spruce<br>Black spruce | Prince Rupert, Prince George regions | Infested 24% (10–70%) of the cones in 10 areas. |

## Pacific and Yukon Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| A spruce cone gall midge *Dasineura canadensis* Felt | White spruce<br>Engelmann spruce<br>Sitka spruce<br>Black spruce | Nelson, Prince George, Prince Rupert regions | Infested 13% (2–45) of cones at 20 of 38 locations. |
| Spruce coneworm *Dioryctria reniculelloides* Mutuura and Munroe | Engelmann spruce<br>Alpine fir | Cariboo, Prince Rupert regions | Up to 5% of branch tips defoliated over 4 ha near Mahood Falls and 10% of cones infested near Dease River. |
| Spruce seed midge *Mayetiola carpophaga* (Tripp) | White spruce | Prince Rupert region | From 5 to 20% of cone infested at three locations. |
| A spruce seedmoth *Cydia strobilella* (L.) | Sitka spruce<br>White spruce | Prince George, Prince Rupert regions | Infested 18% of cones at 18 of 35 locations. |
| Spruce spider mite *Oligonychus ununguis* (Jacobi) | Sitka spruce | Vancouver Island | Light infestation in two seed orchards. |
| Squirrel damage | Lodgepole pine | Yukon Territory, Nelson, Prince George, Prince Rupert regions | Cone stripping killed tops and branches on several thousand trees between Watson Lake and Jakes Corner. Elsewhere debarking caused branch dieback and killed young trees in small patches. |
| Stalactiform blister rust *Cronartium coleosporioides* Arth. | Lodgepole pine | Cariboo, Kamloops, Nelson, Prince George, Prince Rupert regions | Mortality generally light, but up to 60% in some stands. |
| Striped alder sawfly *Hemichroa crocea* (Geoff.) | Red alder | Cariboo, Prince Rupert regions | Moderate and severe defoliation near Bella Coola but declined from Kitimat to Terrace. |
| Sunscald | Lodgepole pine<br>Western red cedar<br>Amabilis fir | Prince George, Vancouver regions | Stem and branch damage light and scattered in young stands, along roadsides and in seed orchards. |
| Sydowia tip dieback *Sclerophoma pithyophila* (Corda) Hoehn. | Lodgepole pine<br>Western larch<br>Douglas-fir | Cariboo, Kamloops, Nelson, Prince George regions, Yukon Territory | Scattered top dieback in young pine near Watson Lake, on larch near Suttleworth Creek, on a third of the Douglas-fir planted west of Canal Lake, and branch dieback near Uslika Lake. |
| Tar spot *Rhytisma salicinum* (Pers.) Fr. | Willow | Prince Rupert region | Light and moderate in the Kitimat, Kallum, and Nass valleys. |
| Tip blight *Delphinella* spp. | Alpine fir | Nelson, Prince Rupert, Prince George regions | Declined in east Kootenays, but moderate to high infections of current growth occurred in northern regions. |
| Twig beetle *Pityophthorus* sp. | Lodgepole pine<br>Douglas-fir | Prince Rupert region<br>Vancouver Island | 15–70% twig mortality in scattered patches. |

## Pacific and Yukon Region

| Insects, Disease, or Damage | Host(s) | Location | Remarks |
|---|---|---|---|
| Twig borers<br>*Dioryctria pseudotsugella* Munroe | Douglas-fir | Kamloops region | Common with western spruce budworm. |
| *Dioryctria* sp. | Lodgepole pine | Prince George, Prince Rupert regions | Commonly associated with rust cankers. |
| Variegated cutworm<br>*Peridroma saucia* (Hubner) | Lodgepole pine<br>White spruce | Cariboo region | Damaged new seedlings and postponed planting schedules in a small area near Quesnel Lake. High numbers of overwintering pupae may not survive the winter. |
| Warren's root collar weevil<br>*Hylobius warreni* Wood | Lodgepole pine | Cariboo, Nelson, Prince George, Prince Rupert regions | Common but generally light in natural stands and plantations causing scattered mortality. |
| Western balsam bark beetle<br>*Dryocoetes confusus* Swaine | Alpine fir | All regions | Mortality in chronically infested stands includes more than 130 000 ha. Accumulative tree mortality of up to 67% occurs in some stands. |
| Western cedar borer<br>*Trachykele blondeli* Marseul | Western red cedar | Vancouver region | In dead tops of 4% of the cedar over 100 ha near North Bend. |
| Western false hemlock looper<br>*Nepytia freemani* Mun. | Douglas-fir | Nelson region | Outbreak collapsed. |
| Western hemlock looper<br>*Lambdina fiscellaria lugubrosa* (Hulst) | Western hemlock<br>Western red cedar | Kamloops, Cariboo, Nelson, Prince George, Vancouver regions | Populations at endemic levels after collapse in 1985 due to parasitism and virus. |
| Western oak looper<br>*Lambdina fiscellaria somniaria* (Hulst) | Garry oak | Saltspring Island | Endemic populations following infestation collapse in 1984. |
| Western pine beetle<br>*Dendroctonus brevicornis* Le Conte | Ponderosa pine | Kamloops, Nelson regions | 300 trees killed in outbreaks near Grand Forks, Fruitvale and Ellison Lake. |
| Western pine shoot borer<br>*Eucosma sonomana* Kft. | Ponderosa pine | Kamloops, Nelson regions | Caused leader deformity of 2–10% of trees in several young stands. |
| Western tent caterpillar<br>*Malacosoma californicum pluviale* (Pack.) | Deciduous species | Vancouver region | Expanded for 5th consecutive year on southern Vancouver Island and the lower mainland causing severe defoliation in some areas. |
| White pine blister rust<br>*Cronartiulm ribicola* J.C. Fisch. ex Rab. | Western white pine | Nelson, Prince George, Vancouver regions | Top-kill and tree mortality common and varied throughout host range. |
| White pine weevil<br>*Pissodes strobi* (Peck.) | Sitka spruce<br>White spruce<br>Engelmann spruce | Prince Rupert, Prince George, Vancouver, Nelson regions | Average 38% (2–45%) of saplings currently attacked in the Skeena Copper, and Kitimat valleys, 12% neat Beaverfoot and generally lighter and scattered elsewhere. |
| Winter drying | Lodgepole pine<br>Alpine fir<br>White spruce | Yukon Territory, Nelson, Prince Rupert regions | Severe foliar browning on 580 ha near Carcross. Elsewhere patches of regeneration affected with 8% having dieback and dead terminal buds. |
| Winter moth<br>*Operophtera brumata* (L.) | Garry oak<br>Maples<br>Fruit trees | Southeastern Vancouver Island | Defoliation continued but generally at trace to light levels in patches. |

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